

# CMS News

A Publication of The Clay Minerals Society

September 1991

## Regulations may threaten U. S. scientific societies

**C**MS members who work for agencies of the Federal government, such as the USGS, the USDA, NASA, and The Smithsonian, may soon face a situation that could seriously affect not only their professional lives but the life of the CMS as well.

For virtually the first time in 24 years, the Standards of Ethical Conduct for Employees of the Executive Branch are being revised. In an effort to discourage situations involving conflict of interest, the regulations may instead make it illegal for federal employees to participate in professional society business while at work.

The parts of proposal #2635.806 which could most strongly impact government-employed society members are the following:

"(b) Participation in internal or business affairs: Unless an employee is specifically authorized by statute, executive order or regulation to serve in an official capacity as an officer of a professional association or similar organization, he may not use official

time to administer the internal affairs of any such organization or to carry out its business affairs, or to attend or to participate in meetings or events that primarily serve those purposes.

"(c) Conflict of interest considerations: "An employee who is not simply a member but who serves, other than in his official capacity, as an officer, director, trustee or employee of a professional association or similar organization is prohibited in accordance with 18 U.S.C. 208(a) and the standards set forth in subpart D of this part, from participating in his official capacity in any particular matter that

*continued on page 12*



CMS Conferences provide opportunities for historic meetings: Steve Altaner and Paul Nadeau, Columbia, MO, 1990.  
*High Iron Photos*

Thanks to Ken Towe, who has been Treasurer and Editor-in-Chief, member of three committees, and unofficial advisor in several other areas this year.

## Professor Millot passes on

*The sad news of Professor Millot's passing away arrived just as CMS News was going to print. We hope to have a more complete memorial in the next issue.*

**T**he clay community lost recently one of its founders and very most prominent members. Dr. Georges Millot died suddenly the 9th of September 1991, in his 75th year. Born in Troyes in 1917, he was Professor of Geology at the School of Mines in Nancy (1942-1954), and the Geological Institute of the Uni-

versity of Strasbourg (1954-1981). In the early '60's he founded a research center devoted to clay research in subsurface environments: the Centre de Sédimentologie et Géochimie de la Surface, that he headed until retirement in 1981. He initiated the Association Internationale pour l'Etude des Argiles (AIPEA), was a member of the French Academy of Sciences and the Belgian Royal Society of Sciences, Letters and Arts, and Doctor *Honori Causa* of several foreign universities. We have lost a bright scientist and a dear friend.

*Norbert Clauer  
Strasbourg*

### Inside ...

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## The Clay Minerals Society



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## Letters

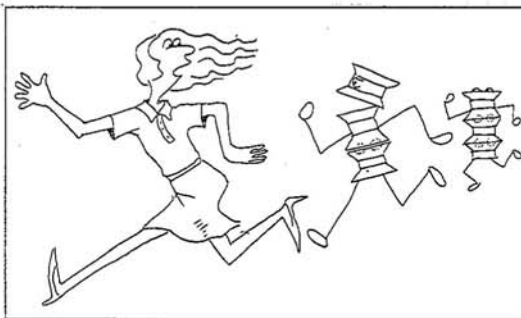
## Clay Science in Great Britain

Dear Editor:

In the March issue of *CMS News*,  
mention was made in the interview  
with Joe White that Macaulay and  
Rothamsted had lost their clay  
groups. This is not entirely correct,  
and I write to keep CMS members in-  
formed of the situation.

Unfortunately, Rothamsted has lost  
its clay group, although Keith Gould-  
ing is still involved with clays to  
some extent. At Macaulay, however,  
I am pleased to report that mineralogy  
has survived (just!) the trauma of re-  
cent years and we still have a small  
but enthusiastic band involved in clay  
research. We still operate in difficult  
times, but our recently revised pro-  
gramme of work has a larger minera-  
logical component than existed over  
the previous few years; this has the  
full approval of the Scottish Office  
Agriculture Department and the Agri-  
cultural and Food Research Council  
who are encouraging us to promote  
international contacts as much as pos-  
sible. There is no doubt that the min-  
eralogy group has been weakened  
(most recently by the voluntary early  
retirement of Jim Russell), but we  
still have Jeff Wilson, Ed Paterson,  
Bill McHardy and yours truly in-  
volved in clays.

So clay research at the Macaulay is  
still alive and kicking. We are grate-  
ful to those who wrote letters of pro-  
test to the government when the fu-  
ture of the Institute was threatened a



Fundamental illite particles from Mars!

Drawing By Peg Buschman

few years ago—we have no doubt  
that these letters influenced decisions  
taken in the corridors of power. The  
situation now is that a new institute is  
being built on our present site in  
Aberdeen to house staff from the  
Aberdeen and Edinburgh sites and  
will be in operation next year.

Best wishes to the CMS and your  
excellent newsletter.

Derek C. Bain  
Principal Editor, *CLAY MINERALS*  
Aberdeen, Scotland

## Czechoslovakian Journal Shortage

Dear Editor:

When I was in Prague earlier in the  
summer, I spoke with some people in  
the Geology Department at Charles  
University and learned about the tre-

*continued on page 15*

## Thanks...

To the following  
people who contri-  
buted to this issue:

AGU  
Derek Bain  
Peg Buschman  
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W. D. Keller  
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M. J. Nash  
Linus Pauling  
Dave Pevear  
Rich Pollastro  
Bob Reynolds  
Charles Roth  
Don Scafe  
Darrell Schulze  
Jan Srodon  
Ken Towe  
David Ward  
Chuck Weaver  
Gene Whitney

## Douglas G. Brookins Memorial

**D**ouglas G. Brookins, Professor of Geology and former Chairman of the Department at the University of New Mexico passed away suddenly and unexpectedly on April 30, 1991. He was a man of passion, intellect, and conviction. He left us at the peak of his productive career, leaving behind a legacy of exceptional accomplishments and contributions to his friends, family, students, and profession. He was a member of the Faculty Senate at the time of his death and had served two previous terms.

Doug's academic accomplishments were world class, beginning with an A.B. degree, *Summa Cum Laude*, from U.C. Berkeley, in 1958, and a Ph.D. from MIT in 1963. He came to UNM as a full professor in 1971, having previously served at Kansas State University, and built a first-class program in isotope geochemistry. He wrote five books and had a sixth in progress, edited several others, and authored or co-authored approximately 500 technical papers, book chapters, and reports. He was a part-time research scientist at the Argonne and Oak Ridge National Laboratories and served on many national and international panels dealing with technical issues associated with geochemistry and waste management and disposal. He was recognized internationally as an authority on the management and disposal of radioactive and chemical wastes, the geology of uranium deposits, and the radiometric dating of rocks and ancient geologic events. He was a Fellow of the GSA, the American Institute of Chemists, the MSA, and the Explorer's Club, and was a long-time member of The Clay Minerals Society.

While at UNM, Doug raised over two and a half million dollars in external research funds, but he was far more impressive in person than his resumé could ever possibly convey.



He was an outstanding teacher at both the graduate and undergraduate levels. He was often elected to teach introductory courses because of his love for geology and because he thoroughly enjoyed the interaction with the students. He relished his interactions with the non-geology students, and always gave them as much time as they needed. The student's enlightenment and enthusiasm was his reward. This interest was manifested in his participation in the development of the interdisciplinary graduate program in Water Resources Administration. He was equally devoted to his own graduate students and led them by example as well as by his teaching. His former students now occupy major positions throughout the country.

At UNM, Doug took strong positions and stood by them. He believed in, and argued forcefully for, science education for all students of the University. Yet he was a man of letters who would take notes in foreign languages just to keep in practice. He was vitally interested in science education in public schools.

In recent years, much of Doug's academic interest focused on problems of radioactive and hazardous waste management. He was one of the first people in this country to recognize and understand the problem of indoor radon gas. He studied the issue extensively and wrote one of the

first books on it. He was an internationally recognized leader in the use of natural analogues for predicting the behavior of radioactive and hazardous material released to the environment. He was one of only a few Americans allowed to visit the Oklo site in Gabon, Africa, where a natural uranium deposit went critical and operated as a nuclear reactor over a billion years ago. Based on his background in geochemistry and years of field and laboratory research, he became a proponent of the Waste Isolation Pilot Plant, a view which, although unpopular, he did not hesitate to express. His background led him to conclude that U.S. asbestos regulations were not justified, based on the negligible threats this material presents. This was another unpopular position two years ago, but is now receiving serious consideration by the regulatory community. He also argued forcefully and successfully for the inclusion of geochemical considerations in remediation strategies for the nation's abandoned uranium mill tailings.

Doug Brookins cared deeply for his family and friends—and for life. His passion for softball far exceeded his common sense, so that every season found him playing with cracked ribs, a bad back, or injured knees. He was devout to his faith and served as President of Congregation Albert. He was devoted to his companion, Judith Binder. He was a devoted father to his daughters, Rachel Brookins and Laura Johnson, and was thrilled with the news that he was to be a grandfather. But that is not to be. Science will miss him. The University community will miss him. His family will miss him. We, his friends, will miss him.

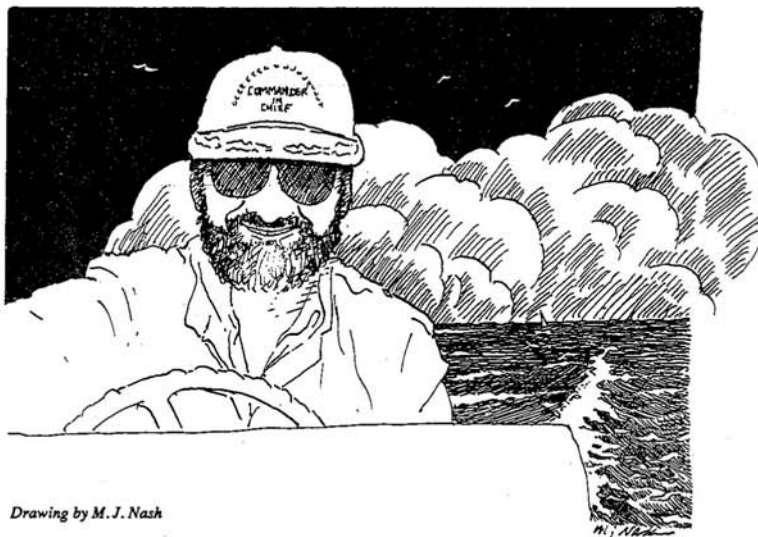
*From a Memorial Minute read at the Faculty Senate, UNM, by Bruce M. Thompson (Civil Engineering) and Wolfgang E. Elston (Geology), contributed to CMS News by David Ward.*

## Interviews with the clay scientists

### Charles E. Weaver

*Charles E. Weaver, Professor and former Director of the Earth Sciences Department at Georgia Tech, was part of the historic Shell Group of the 1950's. From 1963 to 1969, he "fought the engineers to establish an earth science department at Georgia Tech."*

*Named Distinguished Member of The Clay Minerals Society in 1985, he is also a recipient of the Mineralogical Society Award and the Sigma Xi Research Award. While in the Navy from 1943 to 1946, he served on a destroyer in the Pacific, where his unit received a Presidential Unit Citation. He has recently written the comprehensive volume, Clays, Muds, and Shales. The interview was conducted in October 1990 at Columbia, Missouri, by Robert C. Reynolds, Jr., also a CMS Distinguished Member.*



*Drawing by M. J. Nash*

**CMS:** This is a hypothetical question that one of my professors liked to ask young students. Suppose that you're a young Ph.D. in an oil company lab, and that the president of the company comes through on an inspection trip. He's a Harvard Business School graduate in economics, doesn't know anything about geology, and he says, "Why should we study clays? What is in it for us?"

**WEAVER:** I more or less had that question asked of me many years ago.

**CMS:** Good. Well, dig it out!

**WEAVER:** As I recall, in those days, I went to great trouble to explain that there were enormous masses of shale about which other geologists didn't know a darn thing, couldn't subdivide, zone, correlate, or do environments, and that the only hope we had at that time (still, probably) was to try clay mineral X-ray analysis. This was the tool to unravel 75% of the sedimentary record. Sooner or later they bought it, except I oversold it, which you have to do in the initial stages.

**CMS:** It is still being sold, if you look at the kind of papers you're getting at this meeting.

**WEAVER:** There are not too many papers about shale geology. At this meeting, it is basically sandstone properties, which is fine, but at that time sandstones would have gotten nowhere. I was selling shales initially.

**CMS:** Doesn't it often bother you—it does me—that even though 75% of the rocks are shales, the oil companies only core reservoirs. You've got to deal with cuttings pretty much as soon as you get out of the reservoir sands or the carbonate reservoirs. You've got a bad database.

**WEAVER:** That's true. You have to be lucky, or hope, if you've got paleontologists, that the paleontologists can sometimes sell coring shales; so that you get a few there. Basically, in the early stages, I had to convince the regional stratigraphers to handpick cuttings for me. All our work was done not just by grabbing a handful of cuttings, but by some stratigrapher sitting down under a microscope and taking samples of the right units, which I don't think is much done any more. I had to convince them I could help them, and I often did.

**CMS:** It's an art. It's hard to do. I remember the old API 51 volume about recent clay minerals in the Gulf of Mexico. In those days we had a lot of confidence that we were going to use clays to work out the environment of sedimentation. It has turned out that clays are better for determining provenance and diagenesis than environment of sedimentation. Do you think that is a valid statement, or would you disagree with it?

**WEAVER:** Well, you're probably right. I remember we used to follow a sequence of what we thought we could do: the first thing we hoped to do was subdivide a thick

*continued on next page*

**Weaver, continued**

sequence of shale; and then the question was whether we could correlate between wells using these zones; and then, thirdly, we tried to do environments. It was only later that we became concerned about overriding diagenesis that could mask all these trends. Diagenesis put the death nail in a lot of environmental interpretations, particularly for the more deeply buried rocks.

**CMS:** What are a couple of clay minerals that you are pretty sure remember their character from the environment of sedimentation? I mean, you see this baby, and you say, "That's telling me something about whether the water was deep, etc. etc.?"

**WEAVER:** Palygorskite does, and presumably glauconite; but the bulk of clay minerals, I wouldn't trust 'em.

**CMS:** Some people think palygorskite forms in subsaline waters, and some think it forms in supersaline waters. You're one of the subsaline water guys, aren't you?

**WEAVER:** That's right, and I still have never seen any convincing evidence to the contrary. You can build up cases, but they're never 100% convincing; so we still stand by our story.

**CMS:** Okay. Can you tell me why palygorskite is everywhere in the Mediterranean, and in the Upper Cretaceous and Tertiary? It's all over the place in Spain and in Algeria, and even in the Caspian Sea area.

**WEAVER:** At that time the Tethys ocean covered most of Europe. It was shallow, and apparently it had a lot of coastal area and a lot of rainfall; so there were a lot of mixing zones around the borders of this ocean. It is one of my favorite oceans, because a lot happened: authigenic phosphates, palygorskites, glauconites, smectite.

**CMS:** Are the commercial deposits anything like that in Attapulugus, Georgia, or is that hydrothermal?

**WEAVER:** No, it is the same type of ocean, shallow lagoons that apparently had fresh water coming in from the land mixing in with the sea water. I think that all of the North African and European deposits are very similar. Most of the more detailed studies seem to confirm that. The Spanish authors are concluding that their deposits formed in brackish-water environments.

**CMS:** Changing the subject, have you ever looked back after leaving Shell? Are you happy with the way you've worked your life out? Starting with an industrial company

like Shell, and then moving on into academia?

**WEAVER:** Yes. I think industry was a good background. I spent ten years in industrial research with Conoco and Shell. It was very rewarding, but I'm glad I got out, though I didn't get out by choice. I was fired by Shell three months after winning the Mineralogical Society award as the outstanding young scientist. Politics was, and maybe still is, big in Shell. Choose your enemies carefully.

**CMS:** What about all the other guys in your group? You had the greatest group in the clay sciences at Shell. Did they all get the axe, too, or did the thing just fall apart because the center of gravity left?

**WEAVER:** The group was just phased out, to some extent. Well, one of the reasons was that Shell decided to move most of their geological research over to The Hague, figuring they could do it cheaper there than here. I think when they made that decision, it encouraged other people to leave.

**CMS:** They saw the handwriting on the wall. So you went straight to Georgia Tech from Shell?

**WEAVER:** No, I went up to Continental Oil Company in Ponca City for three years. At that time I was desperate for a job, but couldn't get one. I got hired up there basically as a straight sedimentologist.

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*It was only later that we became concerned about overriding diagenesis that could mask all these trends. Diagenesis put the death nail in a lot of environmental interpretations.*

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**CMS:** That's a darned good background though.

**WEAVER:** Oh, it was. I had a crew of a half a dozen guys, and we were doing a model basin study. Conoco was just starting a research lab, and I was the first one that they hired. I had micropaleontologists and petrographers in my group. We spent three years studying the Washakie Basin to construct a basin model. The clay work was just a sideline at the time; so I got a firm grounding in sedimentation and stratigraphy. Then I went to Georgia Tech, got back into the clays, and was never too far away from the clay petrology of sediments.

*continued on next page*

**Weaver, continued**

**CMS:** What do you think have been the worst and the best changes in the way we look at clay minerals? In other words, if you take the profession since you started out in the late fifties, I guess, the field has evolved. It hasn't all been to the good.

**WEAVER:** I was working on clays in the early fifties. I was out of Penn State in '52. So I started work on clays in '48 to '50.

**CMS:** Do you see any trends you don't like in the way clay scientists approach their fields these days, in terms of the backgrounds of the people who do it, the kinds of problems they address, that sort of thing?

**WEAVER:** It's not that I don't like it. I think it's great that they're going into more and more fantastic detail. What I am perhaps sorry to see is that the geologic aspect of it hasn't kept pace with the detailed chemical and structural approach. There is still room for more broad brush geological investigations. I can't see that it really makes any significant difference whether an I/S clay has 73 or 75% illite layers.

**CMS:** Some of these oil guys seem to be making geologic studies. You know that section on the North Sea at the meeting? That looks like complete geology to me.

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*So after grinding out over 100,000 analyses of shales, I established that shales contain a variety of clay minerals....In retrospect I think that showing that shales are not featureless, uniform rocks was probably a contribution that got other people interested.*

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**WEAVER:** That was pretty well synthesized. That was one of the better things I've seen. That was all put together, probably better than we do in the U.S. But perhaps I'm a little out of touch with what the oil companies are doing.

**CMS:** What do you ask your students to do? If a graduate student comes in to Georgia Tech and says, "I want to work with you," what do you look for in his or her background and try to make up? What does it take to make a Ph.D. at your shop?

**WEAVER:** I try to get them to strengthen themselves where I'm weak, which is basically getting more chemistry and physical chemistry than I did. I guess that's the main emphasis. I always regretted this lack in my background. When I was a grad student at Penn State, I was told by Krynine, "Chuck, you need to take physical chemistry." The clay people never said that, but a petrographer did. The geochemists were all taking it, so I went over to the chemistry department and told the people teaching physical chemistry that I was supposed to sign up for physical chemistry. They said "What is your major?" and I said, "Geology," and they said, "Hey, you don't need physical chemistry." I said, "Great!" and walked away. Got wiped out! When I got to Georgia Tech, I knew I was out of it. The first thing I did was sit in on physical chemistry for three quarters.

**CMS:** That means more math. Everything comes together, you know.

**WEAVER:** Yes, you have to get them up through differential equations.

**CMS:** That's what we try to do. Now this is a tough question, but think about it. You've done a heck of a lot of work. What one research project is your most important? I mean the kind of a paper that changes your field forever—and you've had those kind of papers.

**WEAVER:** The answer goes back to the very beginning, when I first came to work for oil companies. Clays and shales were still just one big mass of featureless material that even Pettijohn, at that stage of the game, said were all kaolinite. So after grinding out about 100,000 analyses of shales, I established that shales contain a variety of clay minerals. There's been other studies since then, but in retrospect I think that showing that shales are not featureless, uniform rocks was probably a contribution that got other people interested.

**CMS:** That invented shale petrology, as opposed to clay mineralogy, which is a different field.

**WEAVER:** To some extent.

**CMS:** They can be joined, but they're not the same thing. No, I would agree with it. I remember a paper of yours, maybe it was in '54, in which you said that on the basis of 600 different formations, you're going to draw some conclusions about the clay distribution in sedimentary rocks and shales.

**WEAVER:** It was probably a greater number than that,

*continued on next page*

**Weaver, continued**

because it was after we already had a great deal of data. Actually I've revised that slightly last year in my book, but it didn't change much.

**CMS:** What did you revise?

**WEAVER:** At that time, I was trying to construct the general distribution of clays throughout geologic time in North America. We changed the physil suites here and there a little bit on the basis of another twenty years of data, but no serious changes.

**CMS:** I think, if I quote you correctly from one of your papers, you said that there is no smectite in pre-Middle Mississippian sediments, and you know, that's still just about right. It is pretty hard to find Devonian smectites.

**WEAVER:** Yes, but we've managed to find Precambrian ones in Australia.

**CMS:** Did you really? I'll be darned! In the Ediacara, or older?

**WEAVER:** I don't remember. Kevin Beck came to work with me from Australia. I found that there is some relatively shallowly buried Precambrian down there. He got some buddies of his in the Australian Survey to collect some samples, and we found a nice montmorillonite.

**CMS:** Did you publish that any place?

**WEAVER:** No, I think I may have referred to it in my book in the chapter where I discuss the Precambrian.

**CMS:** Okay, I'm going to have to look that up. It isn't a hydrothermal saponite, is it?

**WEAVER:** No, it's just bedded shale. We also found kaolinite. These Precambrian rocks were just never deeply buried and indicate clay mineral formation has not changed drastically through time. Relative weathering intensities have changed.

**CMS:** Do you think your term "physils" is going to catch on? I think you're the only guy who could get away with it!

**WEAVER:** Someone has to. I did it out of stubbornness. I wrote *Clays, Muds, and Shales*, (CMS) and thought, "It's time to try it."

**CMS:** I think it's a good word. We need something. We

keep saying micas and/or clays. What the heck. We've got to do better than that.

**WEAVER:** In my lectures in clay mineralogy, the first period I spend saying clay is not a clay, and clay minerals are not really clay-sized materials, and all that sort of thing. It's very confusing, and maybe in ten years it will catch on. There's a need for it, but if somebody wants to come up with something more euphonic...

**CMS:** It is a good term. It says what it means.

**WEAVER:** I hate the connotation of "size" and "mineralogy" all in one expression.

**CMS:** I agree. We've been having a lot of papers lately on the origin of illite, and it's a controversial topic. You must have your own ideas on it. In fact, you had ideas on

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*We've managed to find Precambrian smectites in Australia.*

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it the first time I ever talked to you, so I doubt that you've given up on it.

**WEAVER:** I'm sure I did, but I still think that there is a big problem there. Again, they're beating details to death, which is fine, but not for me. I still don't know how much illite is formed by burial diagenesis, and how much just plain grew in the Paleozoic soils under the conditions that favored the formation of illite.

**CMS:** You think it can form in the ocean?

**WEAVER:** Yes, even the ocean, not modern oceans, but in modified marine environments. But the impression I get is that weathering and the environment were such on the continental land mass that illite was probably a common weathering product in much of the Paleozoic. That still remains to be proven. Now everybody's just automatically thinking it was montmorillonite that got converted.

**CMS:** It's darned important, though.

**WEAVER:** That's right.

**CMS:** Because montmorillonite cries vulcanism. If you're going to interpret the regional geology, you've got to know whether it's a soil, or whether it's nearby volcanic soils.

*continued on next page*

**Weaver**, *continued*

**WEAVER:** Right. I personally believe illite grew in soils throughout much of the Paleozoic.

**CMS:** Why do you think this?

**WEAVER:** There is enough literature around that I may have synthesized to some extent in my book. We do see feldspars weathering in soils under fairly arid conditions, alkaline-arid conditions, that are forming illite today. In the Sahara, when you get into the desert areas, the main clay is usually illite. There is a question as to how much is growing there. But I don't think it is a coincidence.

**CMS:** It's alkaline conditions you need, isn't it?

**WEAVER:** Right, and apparently it's on the arid side, and presumably we had that through much of the Paleozoic.

**CMS:** And no plants to add organic acids to the soil, which helps.

**WEAVER:** Right, and some of the work done on the Jurassic and Triassic on the alteration of rhyolite, apparently under the continental conditions and lacustrine conditions, indicate they altered I/S and illite. It's all there in various research projects. It needs to be synthesized with a few research projects. Actually what I wanted to do was get a grant to do some potassium-argon dating of illite to establish its formation in arid continental environments.

**CMS:** That's neat. When I talked about illite in the

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*I personally believe illite grew in soils throughout much of the Paleozoic.*

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ocean, I was referring to the title of a paper you wrote that had these ideas in it.

**WEAVER:** *Potassium, illite and the ocean.* I always like those attention-getting titles, for some reason or another. I kind of like *Clays, Muds, and Shales*, CMS, also Clay Minerals Society.

**CMS:** Yes, I like that. That says it. We've got argillites, and shales and pellites, all these different words for the same thing. Mud is a pretty good word when you come right down to it. It's not a rock.

**WEAVER:** The sedimentary petrographers voted some years back to do away with the word "mud."

**CMS:** Oh, they did? There are no more mudstones, in other words.

**WEAVER:** They said it was such a meaningless term and everybody disagreed, so I kind of agree with them, but it's still a handy term to use, if you don't try to quantify it like they do: two-thirds clay and one-third silt, and so on.

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*Retirement is partly attitude and partly money. If I can get nine months' salary and funding for three months, I have no interest in retiring.*

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**CMS:** I remember being surprised by discovering that it's pretty hard to find a shale that's mostly clay minerals. Wouldn't you agree that most shales are at least half quartz, half silt-sized quartz?

**WEAVER:** No, only in New England mudstones, 30% quartz is what we find. Sixty percent clay minerals, 30% quartz, 10% feldspar + carbonate is the average composition. We did a paper on that. One of my Shell technicians, Dan Shaw, did a quantitative analysis of hundreds of shales. These were legitimate shales-shales; fissile type. People have been coming up with the same number—sixty.

**CMS:** How's your graduate program doing at Georgia Tech? I mean yours, not necessarily the whole school's.

**WEAVER:** For whatever reason, I've never been able to get many Ph.D. students. I've gotten Masters students. I started the department and directed it for eleven years, and so I was busy. I always had research going, but for whatever reason, I've only had a few Ph.D. students. I've got a couple of Masters students now working on clay-carbonate material.

**CMS:** Do you have the same gripe everybody else does, that it's pretty hard to get outside funding? Of course, you've been pretty successful at getting funding.

**WEAVER:** I've been pretty lucky, in that I got involved in that radioactive waste disposal program for about fifteen years, and money was pretty automatic. Then that

*continued on next page*

**Weaver, continued**

sort of petered out, and at the same time I resigned from being the director. I said, "Well, what the hell, I'll start writing a book on clay petrology that pulls it all together." So I spent eight years doing that, and then had to go back to obtaining funding. I got NSF funding, but I had to resubmit the proposal three times to get the clay carbonate study funded. I decided that I wasn't going to give up, and I finally got it.

**CMS:** You know, I reviewed that, and I gave it an excellent, so I'm not one of your critics; but I could tell from your cover letter that you were getting a little peeved at the kind of flack you were getting!

**WEAVER:** Yes, that's right, and the last time I called NSF, I said I'd like to respond to my critics, and I did. By that time we had actual data: there's the pictures; the clays are there; now let us study them! Usually I got a lot of nice reviews, but there's always one guy. Some of the NSF reviews are getting kind of personal, I think.

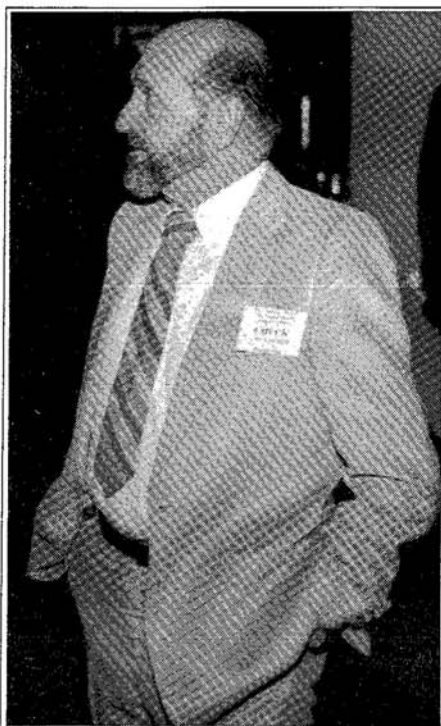
**CMS:** That's bad, and I don't think one bad review should kill a proposal. There isn't a one of us who doesn't have an enemy some place, and if one guy can stuff the whole thing, that's not a good deal. In research you throw out the points that are two standard deviations away. If you re-measure them, you get a different answer. I think maybe when that happens, they ought to resubmit to a couple of other people and get a consensus.

**WEAVER:** I find the NSF does have some control over it, because when they resubmit it, they have to submit it to some of the old reviewers, and they can pick new ones. So of the old reviewers, they can pick the ones that will give a good review, or the ones that will give a bad review. So they can really manipulate it.

**CMS:** They really can. But do you think they really would? I don't think they have an axe to grind.

**WEAVER:** They have no axe to grind; I don't think that's a problem, but it could well be.

**CMS:** Getting back to Georgia Tech, are you still the



*Chuck Weaver at the CMS meeting, Columbia, MO, 1990.*  
*High Iron Photos*

chairman of the department?

**WEAVER:** No. I resigned about ten years ago. We grew from two faculty to twenty and from no graduate students to 80, and again the politics got too heavy, so I resigned.

**CMS:** Do you feel that you get the quality of students you like? Are there enough applicants so you can pick from a pool? Most of us are feeling the pinch in geology. Low enrollments have made their way from the undergraduate ranks into the graduate school applicants—for us, anyway.

**WEAVER:** Oh yes, we're the same way. You more or less take what you can get now. I've got some good graduate students, but you don't pick and choose any more.

**CMS:** They pick and choose now. Do you guys woo graduate students? I mean do you fly them down there to see the sights and recruit them? I know there are schools, Stanford's one of them, that if

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*If filter feeders cause this drastic a change, our interpretations are all screwed up.*

---

they want a graduate student, they'll recruit him like a football player.

**WEAVER:** Right. Atmospheric Sciences, which I brought into our program, do that. We, in Earth Sciences, never have, but we very commonly have graduate students come down on their own to interview us.

**CMS:** You'd say your program is reasonably healthy in terms of funding, students, the whole works?

**WEAVER:** It's healthy, not vigorous.

**CMS:** I'm not going to ask you how old you are, but are you going to retire one of these days, or you going to just keep on going?

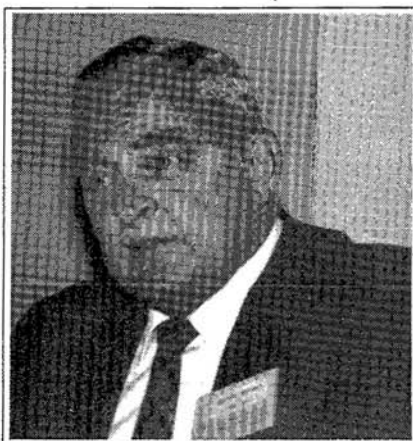
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**Weaver, continued**

**WEAVER:** I don't know. I really have no interest in retiring. Retirement is partly attitude, and partly it is money. If I can get nine months salary and funding for three months, I have no interest in retiring. But it is so difficult to get funding that I'll probably have to retire before I want to.

**CMS:** What kind of a schedule do you teach? Is it all research? Obviously you teach clay mineralogy.

**WEAVER:** I teach one course a quarter, in clay mineralogy, then advanced clay mineralogy, and stratigraphy and sedimentation. We've got a nice team there now; we're doing environmental work and



*Bob Reynolds, interviewer of Chuck Weaver  
High Iron Photos*

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*I wanted to write a critical book because I grew up with the field and felt I had a responsibility to pull it together.*

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we've got organic geochemists and aqueous geochemists. We're in what I call the COW group: clay, organics, and water. I found out long ago you couldn't get away from the three; they're intimately tied up. Now I want to add one more thing that I'm trying to get into, and this is the biota aspect. It's a good future area that's neglected: fungi, bacteria, filter feeders effects on clays. That's going to be an enormously worthwhile area. The biologists and microbiologists have some interest in it, but all they want to know is the size of material the filter feeders drag in; what it is, and what they do to it, they couldn't care less. Clay mineralogists don't seem to care. This is another area that I put in a proposal to NSF. It got supported by the geologists, but the biologists didn't care for it, so I need to get a joint proposal with a microbiologist.

**CMS:** There's a sedimentologist who argues that a lot of shales are fecal pellets from zooplankton, and that's the aggregation process that flocculates the clay. If you do the right kind of ultrathin section work, you can see it. Do you know about that work, and do you have any opinions about it?

**WEAVER:** Yes, I think he's right, but he's overemphasizing it. I don't think that it is a major factor. When you get pellets in the marine environments, fecal pellets are

about the only way clays can get to the bottom, but it is overstated. But this is just part of the game that needs to be looked at from the standpoint of filter feeders. I had a student raising brine shrimp and feeding them montmorillonite and kaolinite. He got all kinds of drastic changes, but he had to leave, so I never knew quite whether to trust the work or not.

**CMS:** Did you get any evidence of diagenesis, if I can use that word, as a result of clay passing through the gut?

**WEAVER:** Yes, he was showing major changes in the alumina-silica chemistry, so major that I didn't know whether to believe the data. We will redo these studies. In 1980 Syvitski and Lewis reported zooplankton changed montmorillonite to a mixture of kaolinite, vermiculite and brucite; biotite and vermiculite were destroyed, and tremolite was partially converted to chlorite.

**CMS:** Oh, gosh!

**WEAVER:** This is what I said to the NSF. "Hey, this needs to be followed up. If there's any truth to this, if filter feeders cause this drastic a change, our interpretations are all screwed up." Of course one reviewer said, "The other fellow already did it; so why would we support more work on it?" So there's one paper that shows drastic changes, and no one seems to be the least bit interested in it, about whether it's true or not. And this paper was pub-

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*I think people are beating illite/smectites to death.*

---

lished 10 years ago. Yes, I'm gonna follow up on that sooner or later.

**CMS:** Have you got any more writing projects in mind?

**WEAVER:** I hope not. Not one of these mammoth things. It's conceivable that if we become enough involved in the clays and carbonate rocks we might publish a monograph.

**CMS:** You've got a lot of guts to write a book on the ge-

*continued on next page*

**Weaver, *continued***

ology of clays. The textbook that Dewey Moore and I wrote stayed out of that because it's so controversial. Nobody's going to argue about Bragg's law, but people are going to argue about how palygorskite formed. You've taken it head on.

**WEAVER:** I wanted to write a critical book because I grew up with the field, and I felt I had a responsibility to pull it together. I'm more geologically involved than 90% of the people involved with the field, so I went out and expressed my opinion, take it or leave it. I welcomed your book, because I was afraid I was going to have to write a similar one for an appendix. I wanted to do something like that for years to give to my students.

**CMS:** Yes, hand something to them and say, "Here, try some of this stuff."

**WEAVER:** It will be a big help. I think people are beating illite/smectites to death, which is fair enough. But an even bigger problem, one with more potential, is the chlorites. The chlorite/smectites, chlorite/vermiculites. The triple or quadruple combinations, plus incomplete hydroxyl layers. There is almost an infinite variety of material.. There's every combination in the book growing in salt deposits and carbonate rocks. Chlorites continue to change up through the shale-slate transition stage.

**CMS:** They're complicated rascals!

**WEAVER:** They're complicated, and they're the wastebasket of clays. I would like to see people who are overrefining the I/S clays move on to the chlorites, particularly the imperfect ones.

Weaver has had two Ph.D. students, Jim Neiheisel and Ady Padan, and about 50 M.S. graduates.

## You know all about underclay? Well, 1993 is the year of **DOWNUNDERCLAY.**

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**Adelaide**  
**South Australia**  
**18-26 July 1993**

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10TH ICC, ELLISERVICE CONVENTION MANAGEMENT, PO BOX 753, NORWOOD 5067, SOUTH AUSTRALIA  
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so we know how many shrimps to throw on the barbie.

Tony Eggleton, President, Australian Clay Minerals Society Incorporated

## *Euroclay '91 in Dresden (26-28 August)*

When the site of this meeting was decided in Sevilla four years ago, the Berlin Wall was still a grim reality, only to become a source of collection items two years later. Organizing a conference during such a special historical period must have been a real challenge. It resulted in some delays of the conference circulars and, generally, in poor advertising of the meetings. Nevertheless, over 400 people made it to Dresden, and I am sure they did not regret it. They encountered warm hospitality and very good organization, which in my opinion fully made up for a certain austerity of the post-communist world (e.g., restaurants, coffee-houses or bars totally absent within a mile from the university where the meeting took place; but the organizers provided food and drink on the spot). Professor Manfred Störr and his group must be congratulated for their organizational success.

During three days, we were offered 60 lectures and 198 posters to contemplate, plus three huge volumes of extended abstracts to read. I found such arrangement of the contributions very practical, because it allowed enough room for intense personal contacts. On the other hand, 200 posters arranged alphabetically and not thematically were rather hard to overview.

About half of all contributions concerned mineralogy and petrology of clays and soils, but over 1/4 reported applied clay research, which reflects an increasing shift towards industrial and environmental research in Europe, including its eastern part. Also, the contributions concerning non-clay but clay-size materials (mostly Fe-oxides) seem to be on the rise.

The Martin-Vivaldi Award went, very appropriately, to Bella Smoliar-Zviagina, a young researcher from Victor Drits' lab in Moscow, for an

excellent talk on relationships between structural parameters and chemical composition of 2:1 layer silicates. From my perspective, at least equally interesting was the poster by her colleague from the same lab, Boris Sakharov, on the applications of his computer program for simulation of tri-dimensional structures of clay minerals, which can handle multi-component mixed-layering and all kinds of defects. Russia is opening, so the program may soon become available for the international clay community. It runs on a PC.

Several papers reported electron microscope studies of clays—the technique clearly in vogue. I enjoyed particularly two very careful studies: on soil kaolinites contrasted with Georgia kaolinite by Gilkes and Singh, and on smectites formed by weathering of different minerals by Eggleton and Wang.

There also were poor posters and poor talks. I would say that the contemporary standards of paper presentation still are more widely obeyed in America than in Europe; a problem to deal with for the European Clay Groups Association (ECGA).

The ECGA has elected its second president, Prof. Radko Kühnel from Delft University, The Netherlands, and it decided to hold its next (1995) meeting in Belgium. The meeting is becoming truly European. One-quarter of the participants of the Dresden meeting came from Eastern Europe. For many Soviet scientists, this was the first travel abroad in their lives. Their attendance was the common success of President Gorbachev, who opened the borders, and Professor Störr, who managed to find sponsors for all East European participants.

*Jan Srodon  
Krakow via Strasbourg*

## *Ethics regulations, continued from page 1*

has a direct and predictable effect on a financial interest of that organization."

Fred Spilhaus, Executive Director of AGU, comments in the editorial, "Creating a Scientific Underclass" in *EOS*, "The consequence of this new regulation would be to prevent federal employees from full participation in scientific societies. This would reverse a long-standing tradition, observed by virtually all federal scientific agencies, of not only allowing but encouraging their scientists to be active in society governance.... The proposed regulations would...only add a prohibition that will be unfair and detrimental to scientific societies, to federal employees, and to the federal scientific agencies. If these new regulations go into effect, scientific societies will lose the talent and energies of a substantial number of their members. These members would be removed from active involvement in the infrastructure of scientific societies and they will lose an important avenue of communication that is critical to the advancement of science."\*

Unfortunately, the deadline for comment on the new regulations is September 20, too late for most recipients of this newsletter to take action. For more information, contact Laura Wilcox at 202-523-5757; address: Office of Government Ethics, 1201 New York Avenue, N.W., Suite 500, Washington, D.C. 20005-3917.

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The Society Office has been researching recycled paper options and now uses recycled paper for most of its printed material and recycles waste office paper.

## Feats of Clay



Dave Bish and J. J. Fripiat, Columbia, MO 1990  
High Iron Photos

Dave Bish has been named a Fellow of the Mineralogical Society of America.

Joe Fripiat has just returned from a summer in Belgium and France. At the University of Leuven, he worked with **Baul Rouxhet** and **George Poncelet**. At the Centre National de la Recherche Scientifique in Orléans, he was working with **Henri Van Dam**.



Photo courtesy Dave Pevear

Archives: **Ross Giese** and **Bull Bailey** adding to the local color in Italy during the 1981 AIPEA Conference.

## New Members

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

Ms. Pamela D. Alley-McReynolds  
8282 Amurwood Lane  
Tomball, TX 77375

Ms. LeeAnn Arrington-Webb  
Thiele Kaolin Co.  
PO Box 1056  
Sandersville, GA 31082

Dr. Patrice de Caritat  
Dept. of Geology and Geophysics  
University of Calgary  
Calgary, Alberta T2N 1N4  
Canada

Dr. Eddy DeGrave  
Proeftvinstraat 86  
B-9000 Gent  
Belgium

Dr. Jacek Deugosz  
Dept. of Soil Science  
Institute of Agriculture  
85-029 Bydgoszcz ul Bernardynska G-8  
Poland

Paul S. Domski  
Limmatauweg 8  
CH-5400 Ennetbaden  
Switzerland

Mr. Les G. Fuller  
Dept. of Soil Science  
Room 362 Ellis Bldg.  
University of Manitoba  
Winnipeg MB R3T 2N2  
Canada

Mr. Robert E. Georgens  
4 Serven Road  
Suffern, NY 1091

Martha M. Graziano  
United Catalysts, Inc.,  
Rheological Division  
1227 S. 12th St.  
Louisville, KY 40210

Dr. Walter E. Grube, Jr.  
Clem Environmental Corp.  
P.O. Box 88, Gordon Road  
Fairmount, GA 30139

William E. Jackson  
Shell Development Co.  
3737 Bellaire Blvd.  
Houston, TX 77025

Mr. Antoine Floribert Mulaba-Bafubiandi  
M.T.M. - K.U. Leuven  
De Croylaan 2, B-3001  
Heverlee  
Belgium

Mr. Thomas M. Murarik  
AWC - Lockheed Engineering  
& Sciences Co.  
PO Box 81074  
Las Vegas, NV 89180

Mr. William E. Riley  
Thiele Kaolin Co.  
P.O. Box 1056  
Sandersville, GA 31082

Ms. Nadine L. Romero  
4475 Hertiage Rd., #B3  
Okemos, Michigan 48864

Dr. Peter C. van de Kamp  
1237 Coombs St.  
Napa, CA 94559

Akihiko Yamagishi  
Dept. of Polymer Science  
College of Science  
Hokkaido University  
Sapporo 060  
Japan

Dr. Jorge L. Yordan  
Thiele Kaolin Co.  
P.O. Box 1056  
Sandersville, GA 31082

Dr. Zhenzhong Zhang  
Dept. of Plant & Soil Sciences  
Univ. of Delaware  
Newark, DE 19717

**Soil Organic Chemist**  
**Department of Agronomy, Purdue University**

**Rank:** Assistant Professor of Agronomy, Soil Organic Chemistry (tenure-track)

**Available:** Immediately

**Duties:** Develop a research program that investigates the interaction of organic chemicals with various inorganic and organic soil components. The applicant will be expected to develop an active graduate and postgraduate training program and effectively interact with other faculty and staff in research, teaching, and extension programs related to the mission of the department. The individual will teach one 3-credit course per year. An advanced graduate level course consistent with the applicant's research program will alternate with an intermediate level course related to organic chemistry of soils. It is also expected that the applicant will actively pursue extramural funds in support of the research program.

**Qualifications:** **REQUIRED:** A Ph.D. in Chemistry, Soil Chemistry, Chemical Engineering or related field. A strong interest in the interactions of organic compounds with soil components. Demonstrated research creativity and productivity. Excellent skills in both oral and written English. Ability to work effectively in a team situation. **PREFERRED:** Training in computational chemistry, e.g. molecular modeling. Training in the chemistry of organic environmental contaminants. Teaching and post-doctoral experience is desirable.

**Application Procedure:** Qualified persons are requested to submit a letter of application, a complete curriculum vitae with publication list, transcripts, and the names, addresses, and telephone numbers of three references. Send to: Dr. William W. McFee, Head, Department of Agronomy, Purdue University, West Lafayette, IN 47907-1150. Telephone: (317) 494-4774.

**Salary:** Commensurate with training and professional experience. Excellent fringe benefit package which includes TIAA-CREF retirement, medical, life and disability insurance and sabbatical leave program.

**Application Deadline:** October 15, 1991, or until a suitable applicant is selected.

**Purdue University is an Affirmative Action/Equal Opportunity Employer. Women and Minorities are encouraged to apply.**

**Soil Physical-Colloidal Chemist**  
**Department of Agronomy, Purdue University**

**Rank:** Assistant Professor (tenure-track)

**Available:** Immediately

**Duties:** Develop a research program in the physical, colloidal, and surface chemistry of soils and clays. The position offers excellent opportunities for collaborative research with scientists in agronomy and other departments. The individual will be expected to attract extramural funding, direct graduate students, and teach two graduate-level courses in alternate years: one emphasizing the scientists's research area and one in intermediate soil chemistry and to effectively interact with other staff in advancing the teaching, research and extension missions of the department.

**Qualifications:** Applicants should have a Ph.D. in Soil Chemistry, Physical Chemistry, Colloid Chemistry, Inorganic Chemistry or related area with emphasis on processes, reactions and interactions that occur on or near particle surfaces. A strong background in mathematics, modeling, and modern quantitative techniques is needed. Teaching experience and the ability to work effectively in a team of scientists is desirable.

**Application Procedure:** Qualified persons are requested to submit a letter of application, a complete curriculum vitae with publication list, transcripts, and the names, addresses, and telephone numbers of three references. Send to: Dr. William W. McFee, Head, Department of Agronomy, Purdue University, West Lafayette, IN 47907-1150. Telephone: (317) 494-4774.

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**Application Deadline:** October 15, 1991, or until a suitable applicant is selected.

**Letters**, *continued from page 2*

mendous financial hardships they are experiencing. Among other things, they have had to discontinue library subscriptions to a number of western journals for lack of hard currency. I thought possibly that among the CMS membership there might be some whose institutional libraries have duplicate sets they would be willing to contribute. Shipments and/or correspondence should go to Dr. Milan Rieder, Dept. of Geological Sciences, Charles University, Albertov 6, 128 43 Prague 2, Czechoslovakia.

The following is a list of discontinued journals, by country of publication. The year indicates the last volume on the shelves.

**France:** *Revue de Micropaléontologie* 1982

**Holland:** *Precambrian Research*

1985

*Sedimentary Geology* 1983

**Germany:** *Contributions to Mineralogy and Petrology* 1985

*Journal of Geophysics* 1985

*Neues Jahrbuch für Geologie und Paläontologie, -Abhandlungen* 1979, -*Monatshefte* 1979

*Neues Jahrbuch für Mineralogie, -Abhandlungen* 1984, -*Monatshefte* 1983

*Palaeontographica, -Abteilung A* 1985, -*Abteilung B* 1979

*Palaeontologische Zeitschrift* 1981

*Tschermak's mineralogische und petrographische Mitteilungen* 1983

**Great Britain:** *Geochimica et Cosmochimica Acta* 1987

*Journal of Petrology* 1982

*Palaeontology* 1985

**U.S.A.:** *Bulletin of the American Association of Petroleum Geologists* 1982

*Geophysics* 1977

*Journal of Geology* 1982

*Micropaleontology* 1976

Warren Huff

Cincinnati, Ohio

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## Ask the Clay Doctor

(Not a real doctor)

**Dear Clay Doctor:** I was pleased to learn from the CMS newsletter feature, "Interviews with the Clay Scientists," that some scientists are involved in formal religious practice. Are clay mineralogists more religious than other scientists?

Earth Angel, Duluth

**Dear Earth Angel:** In their own way, clay scientists are very religious, as you can see in the accompanying photo.



At the Columbia meeting, Professor Alain Baronnet leads a small congregation in horizontal prayer.

**Dear Clay Doctor:** How does the Clay Doctor react to "Healthful Clay?"

Mud Dauber, Columbia

**Dear Mud Dauber:** It has long been known that a healthy soil, which presumably contains healthful clay, is important for growing healthy plants. However, modern agriculture, which uses soil to supply nutrients to growing plants that are then harvested, processed, cooked, and eaten, is a terribly wasteful system. I advocate eating the soil directly, thereby eliminating the energy inefficient intermediate steps. Some delicious recipes are available for mud pie, and for Wyoming bentonite suspension soup, which is quite filling.

**Dear Clay Doctor:** This is a personal matter, but perhaps you can help. Every time my wife encounters a Cretaceous bentonite bed containing I/S with >60% expandability, she calls it "neat stuff" and makes little balls out of it to throw at me. What should I do?

Swell Guy, Utah

**Dear Swell:** Whenever my wife does that, I immediately dehydrate the interlayer space. You can't make little balls as easily with dry bentonite. With regard to her use of the phrase "neat stuff," I think you should act like an adult and do what I do: hold your breath until she stops it.

**Dear Clay Doctor:** I have read with increasing interest reports to the effect that clay minerals may have played a vital role in the origin of life. Can you explain how?

Signed, Intrigued in Ishpeming

**Dear Intrigued:** Recent startling discoveries by Japanese and Australian researchers working independently on clays using new-found methods of hypnosis have shed additional light on this hitherto poorly understood phenomenon. Let me provide a bit of background first. In order for something to be considered living, it must have a memory. In contrast to modern clays, primeval clays were dumb. That is, they couldn't remember a thing. Some modern descendants of these primitive structures are palygorskite and berthierine.

Dumb clays evolved into smart clays such as corrensite and beidellite by dubious and slightly underhanded methods of cation exchange early in the Precambrian. They progressed from the disordered, dumb state through short range smart with 24-hour recall to long range smart with total recall. The smart clays then set about teaching this new form of artificial intelligence to large organic macromolecules, which had been merely passive, disinterested observers up to that point. They set up clandestine vocational schools and worked well into the night teaching organics vital subjects such as how to write a proper abstract and how to make a motion during a formal debate. And so, dumb macromolecules developed into smart ones and learned critical skills such as how to file lawsuits and interpret diffraction patterns. More effort was put into teaching nightlife rather than daylife, which explains the behavior of many clay scientists at national and international meetings.

**Dear Clay Doctor:** Is there clay on other planets?

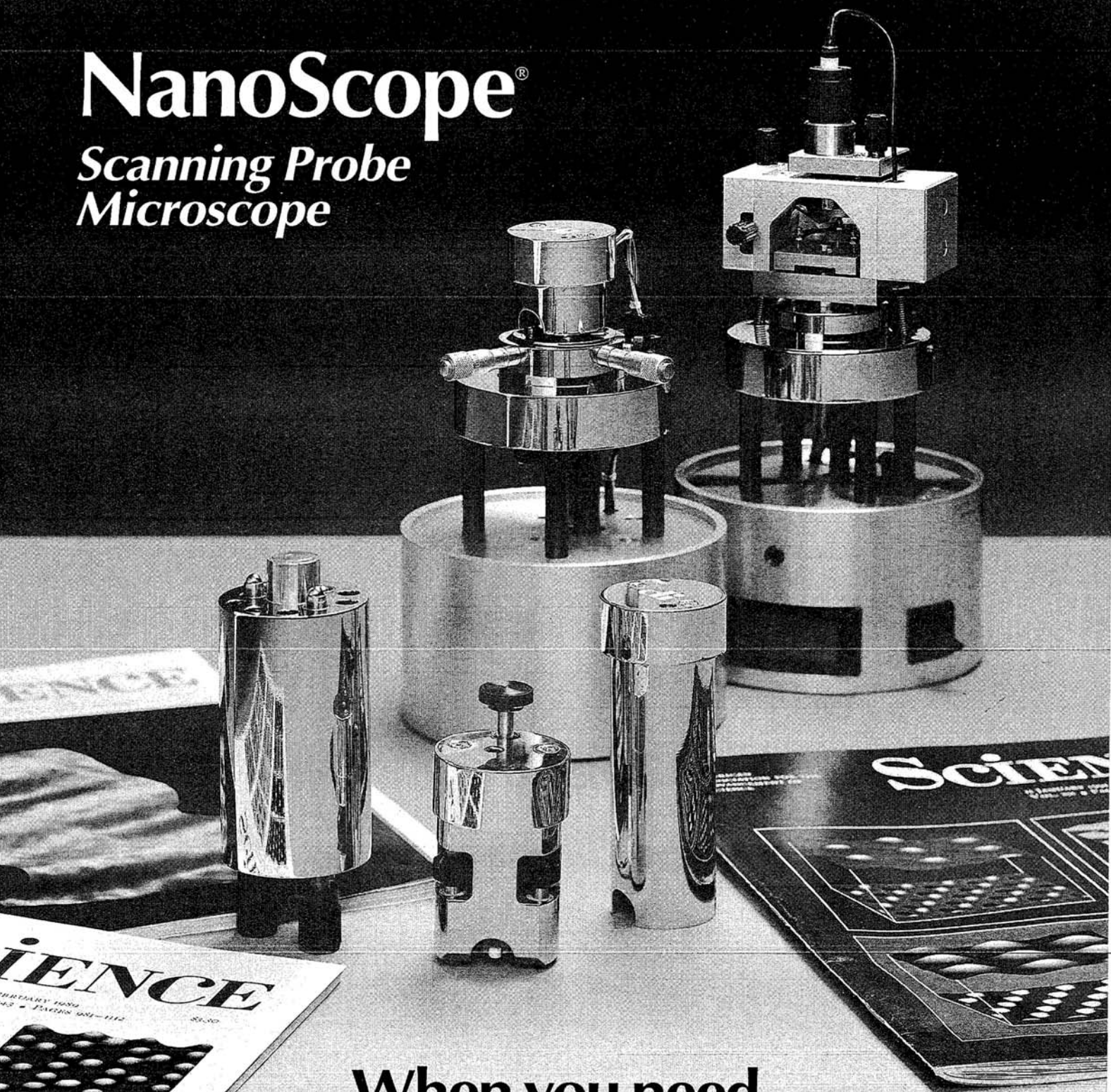
Spaced, Mendocino

**Dear Spaced:** There is some evidence for clay on other worlds. In episode #57 of *Star Trek*, Captain James T. Kirk and the crew of the Starship Enterprise had to deliver Elaan, the Dohlman of Elas, to the planet Troyius for her marriage to this planet's leader. During the scene in which Kirk is seduced by Elaan's hypnotic tears, the observant viewer may have noticed what appeared to be a reddish clay beneath what appeared to be a fiberglass boulder. This clay may have been nontronite.

*The Clay Doctor is available for consultation. Please send contributions to the Society Office*

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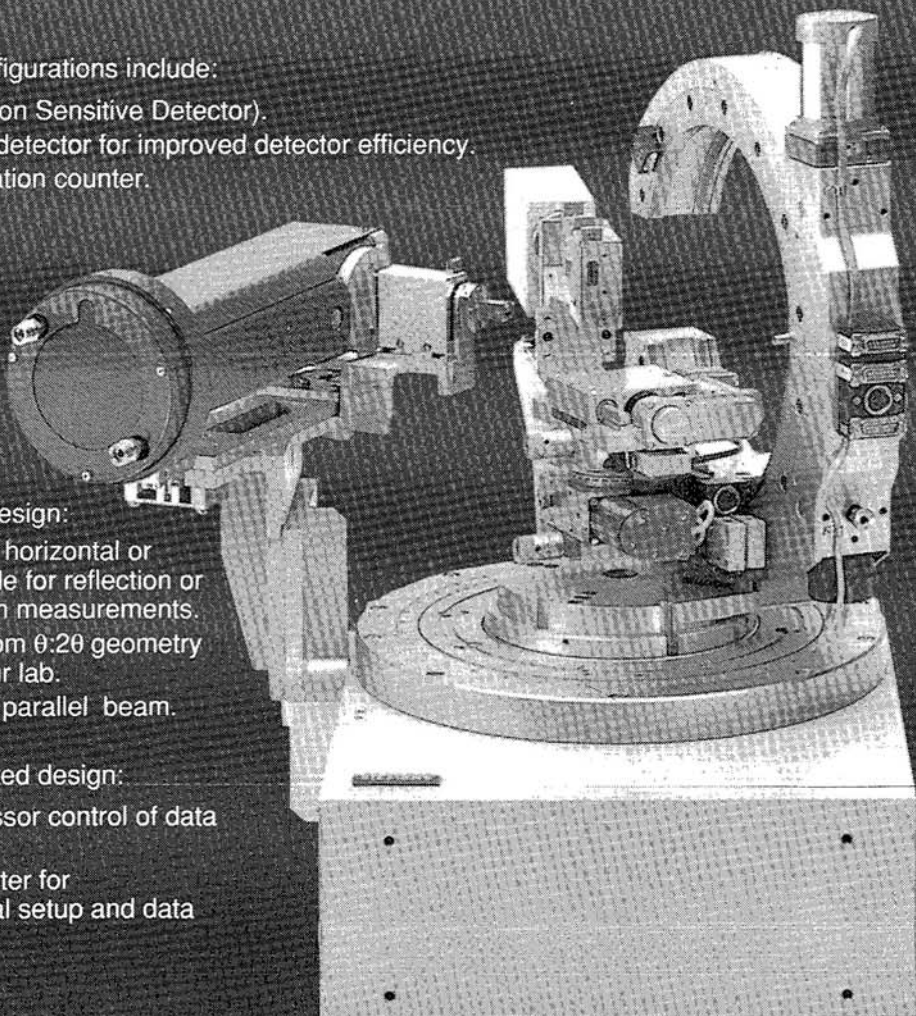
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## Scientists and human suffering

The following excerpts are from the Nobel Symposium 14, "The Place of Value in a World of Facts," published by John Wiley & Sons, Inc., 1976, and contributed by Linus Pauling, the discoverer of the basic structure of clay minerals and the recipient of the Nobel prize in chemistry and the Nobel peace prize.

The greatly increased understanding of the nature of the world and the tremendous technological developments to which it has led during recent decades have forced scientists to become involved in politics. I believe that this involvement must become ever greater in the future, and that it will lead to a changed world organisation such as to provide the opportunity for the most satisfying lives for all people, and to minimize the amount of human suffering....

The goal of a better world cannot be achieved without a much larger number of dedicated scientists in important government posts, to which they can bring their special knowledge and understanding.

There is also the possibility that scientists could play an important part in politics by occupying leading posts in the legislative and executive branches of governments. This aspect of scientists in politics is now the least significant, in most countries. There is no scientist in the Congress of the United States although many questions that are debated in the two

Houses of Congress are related to science, and might be significantly illuminated by their discussion by several scientists serving as Representatives or Senators.

Those rather few scientists who have been candidates have been defeated by lawyers or business men or professional politicians who opposed them, or, in the very rare cases when they have been elected, have served only a single term. I fear that the training of a scientist, the inculcation of the sort of morality that lies at the basis of all science, respect for the truth, unfits him to serve in the Congress....

Scientists do not go into politics because they.... are unwilling to resort to the dissimulation, double-dealing, and chicanery involved in the life of many successful politicians....

The evidence of my senses tells me that I am a man, like other men. When I cut myself I am hurt, I suffer, I cry out. I see that when some other person cuts himself he cries out. I conclude from his behavior that he is suffering in the same way that I was. None of my observations leads me to believe that there is something special about me that sets me apart from other human beings, in any fundamental way; instead, I am led to believe that I am a man, like other men. I want to be free of suffering to the greatest extent possible. I want to

live a happy and useful life, a satisfying life. I want other people to help me be happy, to help to keep my suffering to a minimum. It is accordingly my duty to help them to be happy, to strive to prevent suffering for other people. By this argument I am led to a fundamental ethical principle: that decisions among alternative courses of action should be made in such ways as to minimize the predicted amounts of human suffering. This principle, of course, is not new...

I feel that, although we have theoretical freedom allowing various ethical systems to be formulated, the choice of a reasonable and practical ethical system is highly restricted by our knowledge about the nature of the physical and biological world, and that the only acceptable ethical systems are those that are essentially equivalent to that based upon the principle of the minimization of human suffering....

I believe that it is necessary to attack the problem of the great amount of unnecessary human suffering in the world. I believe that it is only scientists who can analyze this problem in a sufficiently thorough way, and formulate the procedures by which it may be solved.

Linus Pauling  
Palo Alto, California

### Secrets of the Earth

Happy the man whose lot it is to know  
The secrets of the earth. He hastens not  
To work his fellows' hurt by unjust deeds  
But with rapt admiration contemplates  
Immortal Nature's ageless harmony  
And how and when her order came to be,  
Such spirits have no place for thoughts of shame.

—Euripides

