Science & Math CESE Education

The

BEACON

News from

The Coalition for Excellence in Science and Math Education

Volume XIII, No. 4 *Copyright © September 2009*

PRESIDENT'S MESSAGE

TOWARD MORE OBJECTIVE (AND FAIR) TEACHER EVALUATIONS .

Using raw test scores to evaluate teacher effectiveness will not help improve education in New Mexico, will not tell us which teachers are good at their jobs and which ones are not, and it is completely unfair.

When I hear anything along the lines of "it's for the children," I shudder. I do this because this and similar phrases often mean that data and logic have been replaced by reasoning processes that simply feel good. No Child Left Behind was a feel-good measure when it passed, but it doesn't feel so good now. It places unrealistic expectations on our school systems and has actually caused many states to lower their standards to ensure that more students score "proficient" marks on standardized tests. FYI, New Mexico is one of the most honest states when it comes to what counts as proficient. We have not lowered our standards.

What can CESE do about things like this? Many of our members are scientists, mathematicians and engineers with extensive training in data analysis. We can analyze the data and we can do it objectively. As a 501(c)3, we can honestly claim that we do not represent the interests of any political party. People will listen to us because of that fact.

The current hot-button issue in education is pay for performance. (Paying teachers more if they perform better.) A 2007 Gallup Poll found that 92% of the populace feels that "Financial incentives for teachers based on their performance" would be either very effective or somewhat effective at attracting and retaining [highly qualified] teachers. A 2008 Gallup poll found that 76% of the populace would support designing a career ladder for teachers "based primarily upon demonstrated effectiveness in the classroom." While polls like these say nothing about how good any such systems would be or whether they should be implemented, they do say that policy makers will not meet resistance from a majority of the population if they move to implement such a system.

Aside from political issues and pay for performance, there are good reasons to evaluate teacher effectiveness. An objective and accurate system of evaluation can

Continued on page 2

The Beacon is published quarterly by the Coalition for Excellence in Science and Math Education (CESE). A 501(c)3 nonprofit corporation, we are incorporated in the State of New Mexico. Visit our web site at www.cesame-nm.org.

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CESE annual dues are $25 for individual, $35 for family, and $10 for students. Please make check payable to CESE and mail to 11617 Snowheights Blvd. NE, Albuquerque NM 87112-3157. Email Beacon submissions to Editor, Nancy Shelton, nshelton10@comcast.net

Continued from page 1

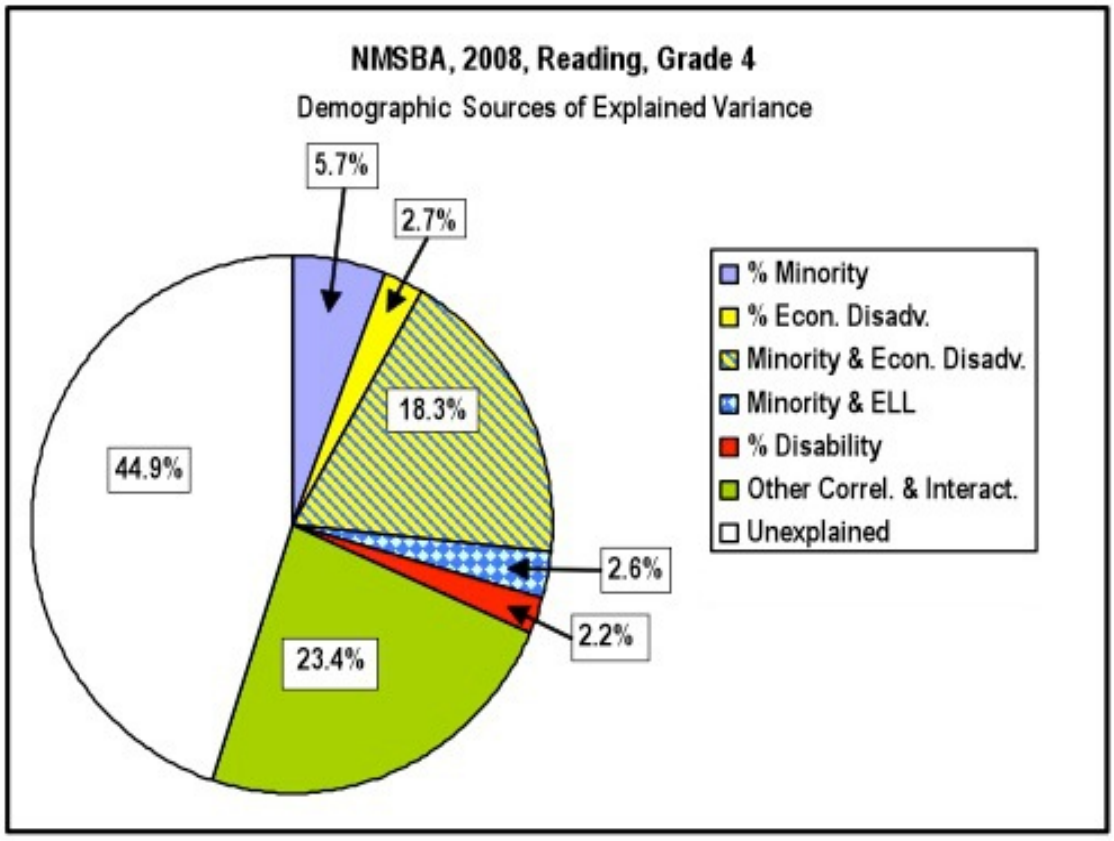
help us identify struggling as well as exemplary teachers.It can also help us to evaluate the effectiveness of teacher-training programs and workshops. This knowledge can be used to improve our school system, and that is in line with CESE's whole reason for being. While we are primarily concerned with science and math education, we will certainly affirm improvements in other subject areas.

What constitutes teacher effectiveness? The best data we have to determine this comes from the New Mexico Standards Based Assessment (NMSBA), a standardized test given to all students in NM. Test scores don't give the entire picture regarding student performance, but they are the best data we have to work with. NMSBA scores also track demographic variables such as minority status and socioeconomic status. This is very handy because the teacher is not the only factor involved when it comes to student performance. It turns out that demographics are normally a better predictor of student performance than the teacher.

Through analysis techniques such as hierarchical regression and canonical correlation, Walt Murfin has been able to make a reasonable determination of which demographic factors are good indicators of student performance. The pie chart titled NMBSA, 2008, Reading, Grade 4 is a real-life example of the factors that indicate how well a student will perform.

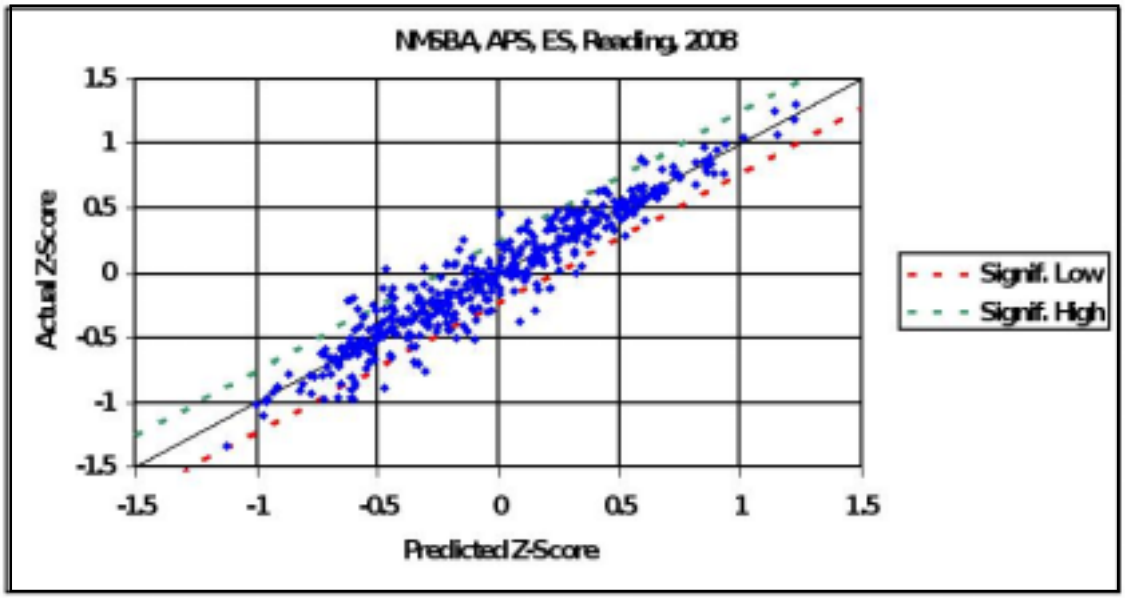
The white section labeled as "Unexplained" in that pie chart is where teacher effectiveness is, yet that white area does not make up a majority of the pie chart. This directly contradicts any statements that teachers have the largest effect on student performance. A more accurate rendition of similar statements is that teachers have the single largest effect on student performance among the factors *within the school system's control.*

Taking demographics into account is important for evaluating teacher performance because demographics are outside of teachers' control. Using a metric such as raw test scores to evaluate teacher performance does not take demographics into account, and thus is unfair. Basing job security and pay raises on raw test scores would lead to an excellent teacher in Gallup getting fired and a terrible one in Los Alamos getting a raise. Simple growth-based evaluation systems are unfair to teachers in schools where the students do not come from disadvantaged backgrounds because it's much harder to go from the 95th percentile to the 99th than it is to go from the 5th to the 30th.



Now that we know how demographic factors weigh in when looking at student performance, we can use demographic data on the school and teacher levels to predict what student performance *ought* to be. Once that prediction is made, we can compare the expected student performance to actual student performance. (This same analysis can be applied at the school level too.) The graph titled NMSBA, APS,ES, Reading, 2008 is an example of predicting student performance based on demographics, and comparing the expected performance to the actual performance.

This graph was made using actual APS elementary school data. The solid black line is the



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Continued from page 3

predicted (expected) score; the dashed lines are boundaries that signify scores significantly higher or significantly lower than the prediction, and the tiny diamonds are actual scores. As you can see, the correlation between demographics and scores is very high. That should really drive home the point that using raw test scores to evaluate teachers is a very bad idea.

I cannot stress enough that there are teachers whose students perform significantly higher than expected, and teachers whose students perform significantly lower than expected. This shows that no innate condition, biological or otherwise, leads to the poor performance in disadvantaged groups. We need to know what those high performing teachers are doing that other teachers aren't. If we can find that answer, we will know how to improve our school system as a whole. While we don't have that knowledge right now, we know where to find it. Knowing that is half the battle.

CESE can make this kind of analysis available to public officials who would use it to improve our school system. My hope is that this would be used to identify teachers who are doing far better than expected in order to learn what they are doing right. These teachers should also be recognized for doing an exemplary job. The analyses should be used also to identify teachers who need help so that they may receive it.

There's a good chance that some form of pay for performance will become a reality in our school systems. While CESE will not take sides on pay for performance politics, we must be able to provide a method for evaluating teacher performance that is both fair and objective in the event that pay for performance does get pushed through by our policy makers. We have to do the best we can, no matter what system we are working with.

Thank You to Walt Murfin (CESE Statistician) for long hours spent analyzing NMSBA data.

Jesse Johnson
CESE President

Who Reads *The Beacon?*

We find it appropriate, every now and then, to remind our contributors, as well as our writers, of the extent of our audience. We snail-mail about 300 copies of each *Beacon* to our N.M. Senators and Representatives in Washington, selected state legislators, and local school boards for example, as well as dues-paying members, some of whom are out of state.

In addition to the above, some dues-paying members, as well as an unknown number of others, choose to read *The Beacon* on-line. We welcome all of them to our web site which attracts visitors from around the world (more than two dozen countries). Surely some of them find their way to *The Beacon*. (During a recent period, our web site had nearly as many foreign as U.S. visitors: 8300 foreign vs 9100 U.S.)

We gratefully welcome dues and gifts to our tax-deductible 501(c)3 corporation.

Jerry Shelton
Treasurer

Letter to the Editor

I would like to compliment *The BEACON* for the stimulating and educational articles I have been reading in it. I have two subjects on which to comment.

First, the concerns of President Lisa Durkin and the *Team Report for Noticias* by Cindy Chapman were (probably intentionally) quite related. As I read the latter, I was awakened and fascinated by the human and cultural elements of mathematics. Years ago I read a delightful essay entitled the Human Elements of Mathematics in which the symbols A, B, and C were given distinct personalities as they played out the "thought problems" of elementary arithmetic. Indeed, it was always more interesting to me in elementry school classes to solve "thought problems" first as they were intended and then by any alternative means I could create.

This brings me to the import of Ms. Chapman's article as it applies to Ms. Durkin's concern for the effectiveness of our math education process. In countries where math is applied to economic and cultural situations (thus creating, apparently, the challenge of equity and fairness in teaching multiple culture mathematics) there is naturally an enhanced level of interest to solve the described situation, not just the theoretical mathematical problem. Many American students simply shrug at the math requirements for graduation and say to themselves, "I'll never actually use this stuff—I wish I didn't have to learn it." I believe it is this lack of motivation that short-changes our effectiveness, and that more situation-oriented applied math approaches would go far in replacing memorization with critical imagination. What could be more exciting than realizing it is our mathematics that has informed us of the possibilities of "dark matter" and co-existing universes?

Second, the article by Dr. Paul Braterman continued the ongoing dialogue on religious creationism versus scientific evolution. There are members of my Unitarian congregation who would probably comment on the possibility of "religious evolution." I thought I'd comment instead on "evolving creation."

To begin with, it is usually the fundamentalist Christians who sponsor creationist ideas. This is largely because the Romans under Constantine and his Council of Bishops transposed earlier Judeo-Christian ineffable monotheism into a trinity that identified the "persons" of God in a more concrete, specific pantheon that heightened the element of personality and personal allegiance.

But there is an additional and very fundamental concept underlying the whole Judeo-Christian interpretation of our being. Relying on the legend (as it was understood before the text was canonized) of a six-day exercise of "creation," the later "believers" assumed the story was literally accurate and the process was complete. Therefore "evolution" could not be either needed or possible—everything was already in its "final" form. But simple observation would have given a more inclusive picture, as indeed it still does.

Not only does every person, animal and plant obviously go through change—growth and decline—but in modern times we know that even our vaccinations may fail because the virus or bacteria designed to bolster our immune system mutated to combat that very system. Indeed, the very essence of "life" is change, a process of interaction that produces variation. We see it very personally in the mating of humans that produce blended racial children. We see it everywhere. What we should know is that the process of creation is not a static one-time act and does not produce a "still" picture of the universe. This would not be a living universe. Creation is an ongoing process that is the constant change we call life.

If the "believing" religious person could outgrow his reliance upon an anthropomorphic god and upon a universe frozen in a still picture, he could be on the same track as a scientist. Both would consider that an ultimate "cause" of all being may exist, but there is no evidence possible to describe that existence. We would be constrained to "know" our cause only by the "effect" of the living universe that has resulted. Neither religion nor science ever described the creation process as being *ex nihilo*.Thus we could be compatible—each believing what is comforting about the nature of some Cause of all being, but concentrating on the realities of "what is required of us" for successful living in a changing universe.

Respectfully,
George Oppenheimer, Jr.

SHRINKING SHEEP, CAPRICIOUS CLOUD COVER, AND OILY ALGAE; Some Summer Sidelights on Climate Change

Climate and cloud cover: This summer has seen a number of news stories about climate change—past, present, and future. The most pessimistic of these, published in the journal *Science,*[1] concerns the interaction between warming and cloud cover. The role of clouds is one of the most difficult things to model accurately, and a great deal depends on their height and location. Low-lying cloud, however, has a direct cooling effect, because it casts a shadow, and scatters sunlight back into space.

Warm air over the oceans will pick up more water, and if this gives rise to more cloud, that will moderate the warming effect of greenhouse gases. On the other hand, the warm air can hold on to the water more effectively, so we might actually end up with less cloud, more light getting through to warm the oceans, and more water vapor—itself a powerful greenhouse gas—left in the atmosphere. That would give a positive feedback loop, amplifying the original warming.

The study reported in *Science* compares annual temperatures in the Northeastern Pacific with amount of cloud cover, and the results are quite clear. In this part of the world, at least, comparison of yearly averages showed that warmer years were associated with less complete cloud cover, as expected if the feedback loop is positive. Not surprisingly, the climate model that most accurately reproduces this is among the more pessimistic regarding the effects of greenhouse gases. The feedback loops between temperature, humidity, and cloud cover are still among the most difficult and contentious issues in climate forecasting, and it will be important to find out how far this particular finding can be generalized. Nonetheless, it looks as if things are at least as bad as we had feared, and may actually be rather worse.

Plankton skeletons and climate past: What of climate—or at any rate, carbon dioxide—past? We know what carbon dioxide levels were like in the geologically recent past, from the analysis of gas bubbles trapped within ice cores, but this record only goes back some 800,000 years. We have marine sediment cores that go back far beyond that, but sediments do not trap gas, so the problem was to find some indirect indicator of CO_2 levels.

This problem has now been solved[2] from what was (to me at any rate) an unexpected direction. Foraminifera, single celled plankton less than a millimetre across, build themselves beautifully structured shells that are made predominantly of calcium carbonate.[3] It turns out that one particular species, *sacculifer globigerinoides* to its friends, also incorporates small amounts of borate, and that the ratio of boron-11 to boron-12 in the shells is sensitive to atmospheric CO_2, because of its effect on the acidity of the oceans, and hence on the precise chemical form adopted by the boron compounds in the ocean waters.[4] So the $^{11}B/^{12}B$ ratio is actually a good proxy for carbon dioxide levels. This has been verified by comparison with the ice core data, giving us the confidence to use it reaching back further into the past, and we can now look forward to developing a detailed climate record spanning at least the last 2 million years.

More Villains: Back to the present, and it turns out that we have even more greenhouse gases to worry about than we had realized. The production of chlorofluorocarbon (CFC) refrigerants has now been phased out for over a decade, under the terms of the 1987 Montreal Protocol, because the chlorine atoms that they release when destroyed by hard UV in the upper atmosphere catalyze the destruction of the ozone layer. We were, naturally, assured that doing away with CFC's would be economically disastrous, but we seem to have managed somehow. One of the ways in which we have managed has been to replace CFC's with mixtures of hydrofluorocarbons. These are molecules containing only carbon, hydrogen, and fluorine, and can be readily tailored to have similar boiling points and heat transfer properties to CFCs. We can recharge the air conditioner after all.

Unfortunately, they are if anything even more indestructible than CFCs themselves, meaning that over decades they will inevitably build up in the atmosphere. And like all new gases introduced into the atmosphere, they absorb infared light at wavelengths that were not absorbed before, which makes them powerful greenhouse gases. They already account for 2% of the warming effect of US greenhouse emissions, a far from trivial amount that will rise relentlessly unless action is taken. And what will happen when a billion Indians start demanding air-conditioning, as they no doubt eventually will, if all goes well? If all does *not* go well, we will have even larger problems to deal with. Diplomats are already conferring on these matters. Let us hope that they can move more swiftly on this than they have on carbon dioxide.

Shrinking sheep: However, global warming isn't entirely bad news if you happen to live on a bleak windswept island like Soay, out in the North Atlantic a hundred miles west of the Scottish mainland. Actually, the biggest things that live on Soay are Soay sheep. These small but hardy animals are an ancient feral group, and are thought to be closely related to the ancestor of present domestic breeds, but more or less unchanged since Neolithic times.

Scientists from Imperial College, London, who had been studying a flock of these sheep on the nearby island of Hirta, recently reported[5] that they are shrinking, and are now about 5% smaller than they were in 1987, when the study started. They attribute this change to milder weather. Grass is available for more months of the year, so that smaller animals, with smaller fat reserves, are now able to survive the less extended winter. This is actually part of a more general phenomenon. Colder climate goes with larger size, for fundamental reasons regarding the ratio of body area to body weight, which is why polar bears are bigger than grizzlies.

Oily algae: One much discussed way to reduce greenhouse gas emission would be to trap the carbon dioxide from coal-burning power plants. This approach is full of unsolved problems, including where to actually put the carbon dioxide, and how to make sure that it stays there. One way is to have blue-green algae (pond scum) trap it by photosynthesis, a possibility one Chinese company (ENN) is pursuing at its research laboratories near Beijing.[6] There are a number of problems here, among them how to extract the algae from the CO_2-containing growth chambers every day, otherwise they will simply foul up the windows. In addition, China's coal deposits are mainly in the north of the country, where the algae would need to have heat supplied to them to help them grow. There are times, and this is one of them, when I am not sure whether I am looking at a genuine project, or at mere window dressing.

However, there is no doubting Exxon Mobil's sincerity in its own venture into algae production. It is jointly funding a $600 million joint project with Craig Venter, of human genome project and synthetic biology fame, to extract carbon dioxide from the atmosphere by growing oil-producing algae.[7] It hardly matters whether the carbon dioxide happens to come from a nearby coal plant, as in the Chinese experiments, or from the atmosphere in general, especially if sunlight is the limiting nutrient. The process could be worked anywhere, in open growing tanks, and if these require large areas of land, that could be land with few other uses. The algae would be genetically manipulated to optimize their production of oil, which could be used directly as fuel for transport (no doubt they could be manipulated for other uses as well). The remaining organic material could be used as fuel, fertilizer, or animal feed. I find it ironic that a company that has been trying so energetically to cast doubt on the entire concept of climate change,[8] is now at the forefront of some of the most radical research meant to address it. Of course, Exxon Mobil, as an oil company, has other good reasons to be concerned. Fatih Birol, chief economist at the International Energy Agency in Paris, has said that usable oil reserves have already peaked in most of the biggest fields, and will peak worldwide in about a decade, ten years sooner than

Continued on page 8

Continued from page 7

had been assumed. And, as he put it,[9] "we have to leave oil before oil leaves us."

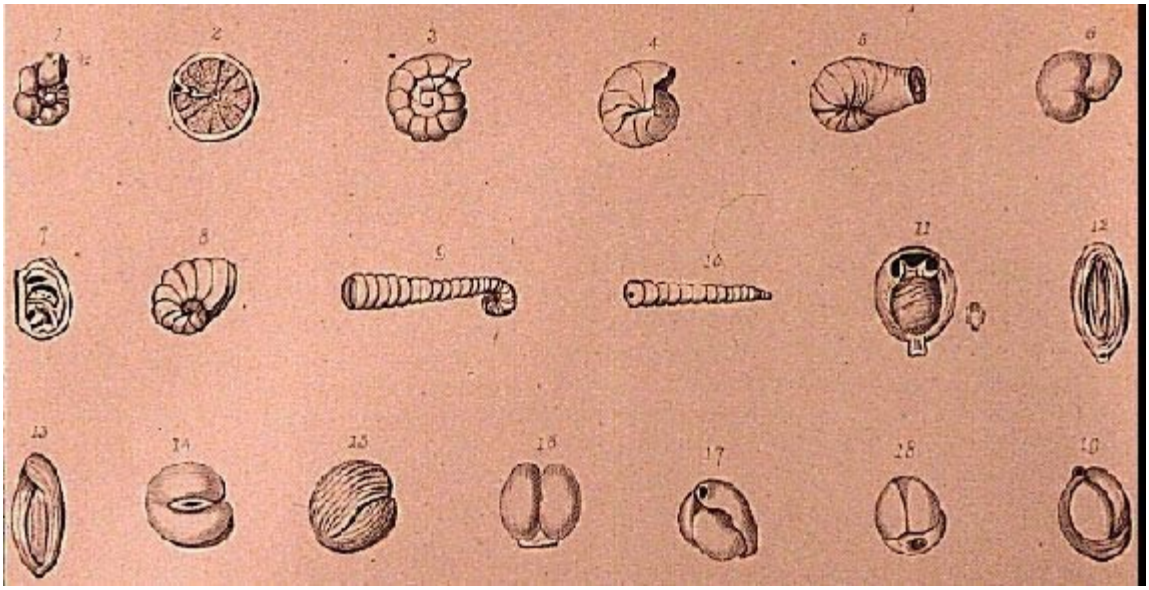
Notes

[1] *Science* 24 July 2009 Vol 325, pp.376 and 460
[2] *Science* 19 June 2009, Vol 324, p.1551
[3] More about these, with a beautiful image of one of the skeletons, at http://www.ucl.ac.uk/GeolSci/micropal/foram.html
[4] Leading to differences in zero point energy, as discussed in last January's *Beacon.*
[5] http://news.bbc.co.uk/go/pr/fr/-/1/hi/sci/tech/8130907.stm
[6] *The Guardian,* Monday 29 June 2009
[7] *New Scientist,* July 25, 2009
[8] Sharon Begley, *The Truth About Denial,* Newsweek, August 13, 2007
[9] *The Independent* [London], August 3, 2009

Paul Braterman
Professor Emeritus, University of North Texas
Honarary Sr. Research Fellow in Chemistry, University of Glasgow

The oldest fossil foraminifera, from the Cambrian, are simple agglutinated tubes. Calcareous microgranular and porcellaneous tests evolved in the Carboniferous, and calcareous hyaline tests in the Permian. Over time, each of these groups has evolved many different forms, including large complex tests associated with reefs. These groups of large species became abundant when reef environments were widespread, then suffered major extinction when world climate changed and reefs were decimated. The fusulinids were one such group. They had rice-grain shaped tests and evolved into numerous widespread species during the Permian but went extinct at the end of that period when a worldwide mass extinction also eliminated most other reef dwelling organisms.

The small size of most foraminifera may make them difficult to see, but it makes them much more useful than larger fossils for applications such as petroleum exploration, because there can be thousands of specimens in the small chips of rock collected when drilling a well. In addition, many species of foraminifera are geologically short-lived, and others are only found in specific environments, so a paleontologist can examine the specimens in a sample and determine the geologic age and environment when the rock formed. As a result, since the 1920's the oil industry has been a major employer of paleontologists who specialize in these microscopic fossils. It is unusual to drill an oil well without a paleontologist onsite to determine when the desired oil-bearing rock layer has been reached.



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Comment from Dave Thomas

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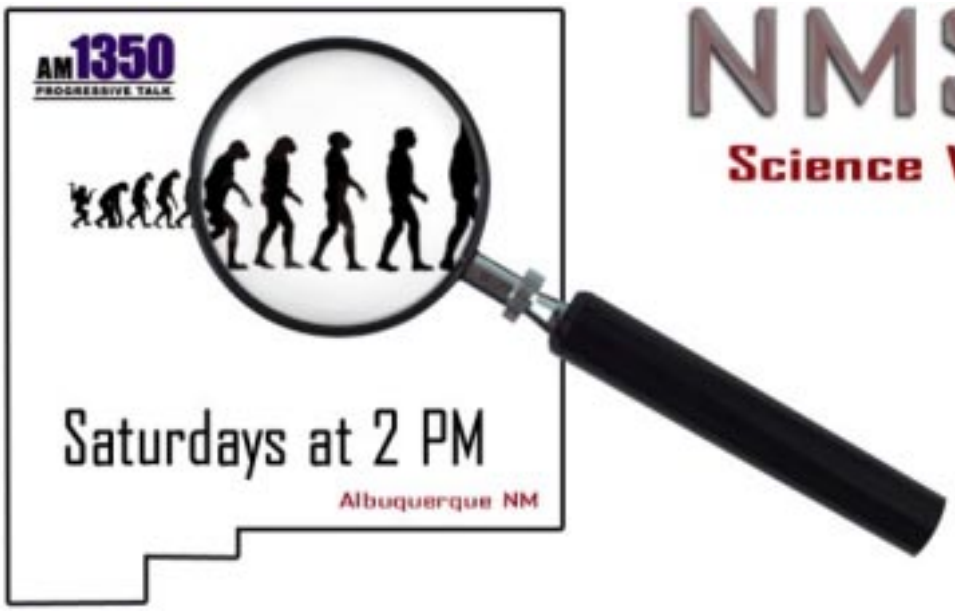

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