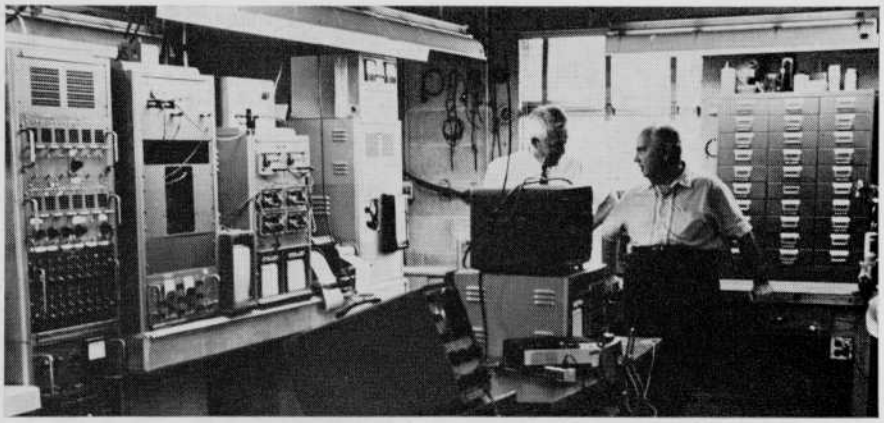
eology. Dr. DuBois presented a paper on the dating of materials at archeological sites through magnetic instruments and on variations of the earth's magnetic field. Through dating of rocks (see the article which follows on the dating procedure developed by Dr. DuBois), the observatory record will in reality be extended back through time. Man has only recorded characteristics of the earth's magnetic field for the past few tens or few hundreds of years. In order to gain knowledge of the field, a much longer record must be discovered. Dr. DuBois and a handful of his colleagues in the scientific community are now measuring materials back to 5,000 years ago. Continuous records have been developed to a few hundred years B.C.

After the Pecos Conference was a meeting in Reno at the NASA University Research Center, on the magnetic exploration of the moon. "We'll arrive probably at a basic plan as to what's to be done, how it's going to be done, and who's going to do it. It's very important to be there," he said before attending.

Another conference on archeomagnetism in Arizona and a geophysicists meeting in Houston followed before Dr. DuBois departed for Europe and the International Conference on Geophysics, held in Zurich and several other Swiss cities. "This meeting is held only every few years. At it the leading world geophysicists get together, exchange data, present materials and findings. There is a lot of new work and much correspondence back and forth before and after. Both sides of Europe attend, and many of them are aware of our work at OU, are interested in it, and want to know more about it. The meeting lasts two weeks, from the latter part of September until Oct. 10, and it's full and complex.

"It's important that as fast as the scientific field is moving in this area that we don't lose any time and that we keep a full research effort in progress. In many fields of science, if you lag for four or five years, you practically have to start over again.

"Things are moving so fast. That is why it is critical for us to attend these meetings. First, we're passing on to other scientists what we're doing, so they won't duplicate our effort, thus wasting years. Also, we want to find out exactly what it is they're doing. The medium of publication is almost too slow to exchange information at the rate at which this science is advancing.



*H. O. Harder (right), chairman of the OU Foundation, visits with an observatory staff member.*

"If you want to stay a leader in a field, you must move with it. It means effort on the part of many to keep these programs going. The ways for doing it ten years ago are not aplicable today. We learn too much too fast.

"The work we do leads to interpretations which are useful in the discovery of petroleum and ore and in finding the chronological record of man. The University of Oklahoma is a leader in this field. I should hope we shall continue to be."

Dr. DuBois will spend three days a week at Leonard. The remaining time he will teach and conduct research on campus as he leads OU into the forefront of an expedition into a new territory of science, a frontier important today and invaluable to future generations.

PAUL GALLOWAY

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# *Magnetic Clues Help Date the Past*

*By Kenneth F. Weaver, National Geographic Magazine*

The compass needle, contrary to popular notion, does not point true north. Moreover, its aim today differs from that of a century ago, or of Columbus's day. And, if the compass had existed in the time of Christ, its direction would have been still different then.

In fact, what geologists call the "virtual" or apparent geomagnetic north pole, toward which the navigator's compass points, wanders about the Arctic like a lost child. It may move as much as 700 miles in a century.

This curious and little-understood drifting offers an ingenious key to riddles of the past. Today's archeologist, when he uncovers the kilns, hearths, or fire pits of ancient man, may search for faint traces of magnetism. These traces serve as a "fossil compass." From them the scientist can determine the age of the remains, using a new dating technique called *archeomagnetism*. In the past several years it has dated Roman pottery kilns in Britain and France and ancient hearths in Japan.

In the pre-Columbian Snaketown ruins in the Arizona desert, archeomagnetism has helped clarify a long-standing controversy about the Hohokam Indians. "When we first excavated Snaketown 30 years ago," says Dr. Emil W. Haury, University of Arizona archeologist, "we became convinced that the Hohokam had devel-

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and seemed quite proud to be Russians and quite proud of communism." Two other aspects of his visit caught St. John's attention. "Their streets and public areas are much cleaner and neater than those in this country. There simply are no litterbugs. People put their trash in containers. Part of this might be because they fear a reprisal of some sort, but I think most of it stems from pride in their country. Also, the people on the streets are very well behaved. You never see roaming gangs of teenagers or anything like that. Again, I think this stems from pride.

"The subways in Russia are as beautiful as they are reported to be. One station had a series of scenes in stained glass lighted from behind. Every station is built of marble or beautiful stone; some have beautiful chandeliers. One reason for this artistic decoration is that the average Russian uses the subway and other public transportation a great deal. There aren't many cars, and public transportation is almost free."

In Moscow, which St. John visited on a four-day tour following the conference, one thing which attracted his attention was the number of women seen working in occupations that are considered men's work in the United States. "Women operate the street cars and buses, sweep streets, paint bridges and work on construction gangs. They wear a sort of blue coverall and a scarf. Clothes in Russia, of course, are somewhat different from those in this country. They're durable enough, but the shops don't offer the variety and style you find here. The men's suits are not cut as neatly—the pants bag. And the women's dresses are much longer." The OU professor smiled slightly. "You might say it was two weeks without miniskirts."

## Sooner Scene
### Continued

several, and the skins became a part of our traveling paraphernalia for the rest of the trip. We were fascinated by the stories of the fierce Vikings who explored as far West as the North American continent long before the time of Columbus. We saw the Viking Museum in Oslo, and later the famous Runic stones at Jelling, dating from the tenth century.

Our long trips across Norway and Sweden were made by railway on the modern, comfortable trains that are as fine as any I have seen. We learned that the railway from Bergen to Oslo is the only overland transportation open year-round across this country. Aside from being an easy way to to travel, it was also a great opportunity to see the high mountains with their frozen lakes, beautiful snow and even occasional glacier. We spent a few days plying the fjords by boat along the Aurland Fjord, the Nearoy Fjord, and the great Sogndal Fjord. This is a world in itself. The breathtaking waterfalls, the ladder farms, the goats, the fjord horses, and the mists were all that we had heard and more.

The most interesting stop on the Jutland Peninsula of Denmark was at Vejle. From there we toured the lovely Danish countryside to Jelling, which I have already mentioned, to Golding to visit the mighty thirteenth century ruins of Goldinghus, and to Ribe, Denmark's oldest town. Ribe is located in the marshlands of South Jutland. In the Middle Ages it was a seaport. However, the silt has filled the harbor and the sea gradually retreated leaving the town several miles inland. Ribe has preserved ancient buildings, and there is an air of Medieval beauty in the narrow winding streets of the lovely, old houses where storks roost on chimney tops. For the amusement of tourists, Ribe also maintains a "town crier" who sings the ancient rhymes of reassurance, dressed in medieval costume, carrying a lighted lantern and a staff with a spiked head which was used as a weapon for the protection of the citizens of Ribe.

I've been asked many times what the highlight of this trip was for me. At first, the answer was difficult. However, I found a solution. There are actually many highlights and the answer an inquirer now gets depend upon the time of day and under what circumstances the question is put. It might be any one of those experiences I have enumerated, or an another occasion, it might be the food, the shopping, the interesting, admirable people we met everywhere, or it might be an evening in Tivoli Gardens of Copenhagen, the Norwegian sculptors or the exciting modern designers of arts and crafts found everywhere in Scandinavia.

Since 1961, nearly 1,000 alumni have toured with the Alumni Association Tours, traveling in nearly every section of the world. Eleonore and I felt extremely fortunate that we were able to accompany 34 congenial, interesting Sooners on the Scandinavian Tour this summer. It was a restful and gratifying experience for us.

## Magnetic Clues Help Date the Past

*Continued from page 20*

oped a high degree of culture long before the cliff dwellers farther north. But this idea did not fit the archeological theories of the time. Today, our new magnetic dates tell us we were right. These dates confirm our chronology of Hohokam life, worked out by other means based on pottery fragments and radioactive carbon-14. Now we can be reasonably sure that the Hohokam were the first full-fledged irrigationists in what is now the United States. And we have good evidence that they practiced their advanced arts and agriculture several centuries before Christ."

Fortunately for Dr. Haury, the University of Arizona had on its geology faculty Dr. Robert L. DuBois, one of the very few specialists in archeomagnetism in the United States—indeed, in all the world. By measuring magnetism in clay fire pits at Snaketown, Dr. DuBois derived the magnetic dates that Dr. Haury finds so useful in his chronology. (Dr. DuBois joined the University of Oklahoma faculty in July.)

I had heard of paleomagnetism, the magnetic dating of ancient rocks. But archeomagnetism—magnetic dat-

ing of archeological remains—was something new. I visited Dr. DuBois in Tucson to find out how it works. He drove me out to the University of Arizona farm where his magnetism laboratory stood isolated in a cow pasture, far from the interference of electrical machinery and power lines. We parked a hundred yards away to avoid vibration and magnetic interference.

The laboratory itself—a simple concrete-block rectangle—contains no steel; even the nails are aluminum. Its two rooms are crowded with magnetometers and storage cabinets, each surrounded by skeletal wooden frames ringed with coils of wire to cancel out extraneous magnetism.

"You are aware, I'm sure," said Dr. DuBois, a lanky, crew-cut Westerner, "that the earth acts like a giant magnet, with lines of force sweeping from Antarctic to Arctic. It is this magnetic field with which the compass aligns.

"Now, as every navigator knows, the compass does not point true north. What's more, it does not home in on a single point from all over the world, contrary to what people think. Rather, the compass needle parallels lines of force that may be greatly distorted in local areas. So the apparent pole position depends on where you are, and corrections must be made for navigation. Every locality has its own virtual geomagnetic north pole."

Dr. DuBois explained further that as the years pass, earth's magnetic field constantly shifts in direction and intensity. Why, nobody knows for sure. With the shifting of the field, what appears to be the magnetic north pole for any given locality shifts also.

Scientists have been able to plot the shifting of the pole in relation to Tucson for some 2,000 years past. They do this by finding magnetic clays that can be dated by reference to such organic matter as tree rings or radioactive carbon-14.

"The Hohokam," Dr. DuBois continued, "unwittingly left magnetic records for us by the way they did their cooking. Because leaping flames would consume the brush roofs of their houses, they built fires outdoors, then carried live coals inside to clay-lined pits, where they roated meat and parched corn. Clay, as it happens, contains particles of magnetic minerals, usually forms of iron oxide. When it is baked under sufficient heat—say 1,100° Fahrenheit—the magnetism in the clay orients itself with the earth's field, like the compass needle. And, until it is heated again, the clay retains a weak but very stable 'thermo-remanent' magnetism as a faithful record of earth's magnetic field at that time."

One must not jump to the conclusion, Dr. DuBois cautioned, that the particles or the molecules actually line up. They are not free to move in the way the compass needle is. What does happen is that the spinning electrons that produce the magnetism in the particles begin to move in identical patterns instead of helter-skelter.

And so it is that the incandescent coals in those fire pits baked the thick clay hot enough to alter its magnetism. The magnetic clay recorded the calendar of Hohokam life as surely as a magnetic tape records a Bach chorale.

To take a sample from such a fire pit, Dr. DuBois chips at the brick-hard clay with tools like ice picks until he isolates a small knob. Around this he places a two-inch-square mold, which he carefully levels, orients to today's magnetic north, and fills with plaster to protect the sample. Once the plaster has hardened, he cuts the whole block free.

I saw hundreds of such samples in Dr. DuBois' laboratory. There, too, I saw the magnetometer with which he checks the magnetic bearing of the samples. Essentially the magnetometer consists of three tiny magnets, spaced on a slender rod suspended from a very fine wire in a plastic tube. A thin beam of light shines on a mirror glued to the rod, then reflects, like a pointer, to a numbered scale. Electric currents flowing through large coils of wire on the wooden skeleton around the magnetometer cancel earth's magnetic field. When no sample is in the device, its beam of light points to zero.

But when Dr. DuBois put one of the Snaketown samples on a platform directly beneath the suspended magnets, the entire assembly above it rotated slightly. The reflected beam of light moved acress the scale, exactly like a compass needle, indicating just how far the clay sample had caused the magnets to turn. The geologist upended the block and read the deflection

of the magnets again; he repeated for each face of the block. From these readings, with the aid of a computer, he calculated where the virtual geomagnetic pole was when the clay was fired. Then, with his map of the polar wanderings, he assigned an age to the sample. His results—accurate to within less than 50 years—are more precise than carbon-14 dating would be for charcoal from the same pit.

The two methods complement each other nicely. Archeomagnetism enjoys the advantages of precision and the ability to date lifeless minerals, for which carbon dating cannot be used. However, archeomagnetism will not work with such nonmagnetic materials as charcoal, bone, shell, or wood, for which the carbon-14 method is especially suited. Tree-ring dating, most accurate of all techniques, can pinpoint the actual year a tree was cut, but it can be used only with stumps or timbers from a few kinds of trees.

Meanwhile, as scientists date peoples of the past, it excites the imagination to realize that when we build a campfire on a clay riverbank, we may be automatically recording unseen lines of force, and thus dating this mundane event in our own lives for archeologists of the future.

*A new laboratory for the archeomagnetic dating developed by Dr. DuBois will be built this winter at a site near Norman.*



*ANSWERS TO BUILDINGS QUIZ:*
1-B; 2-S; 3-N; 4-C; 5-R; 6-A; 7-H; 8-E; 9-P; 10-K; 11-I; 12-Q; 13-L; 14-G; 15-F; 16-M; 17-J; 18-O; 19-D; 20-T.