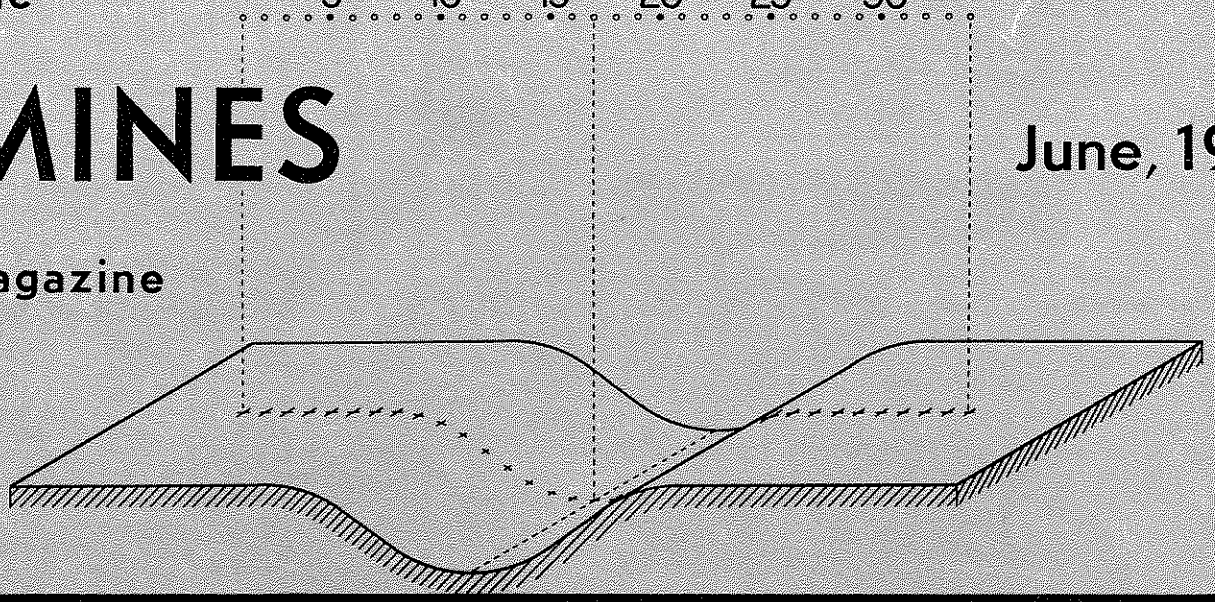
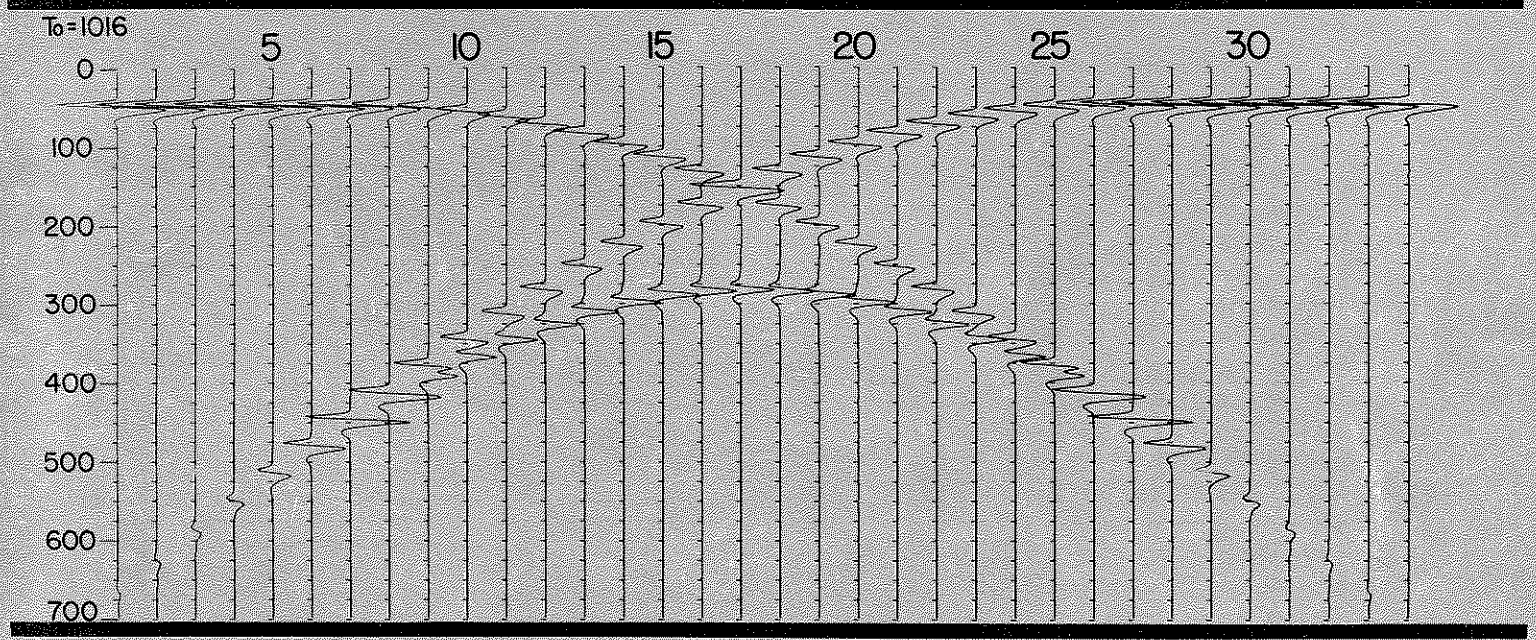
The

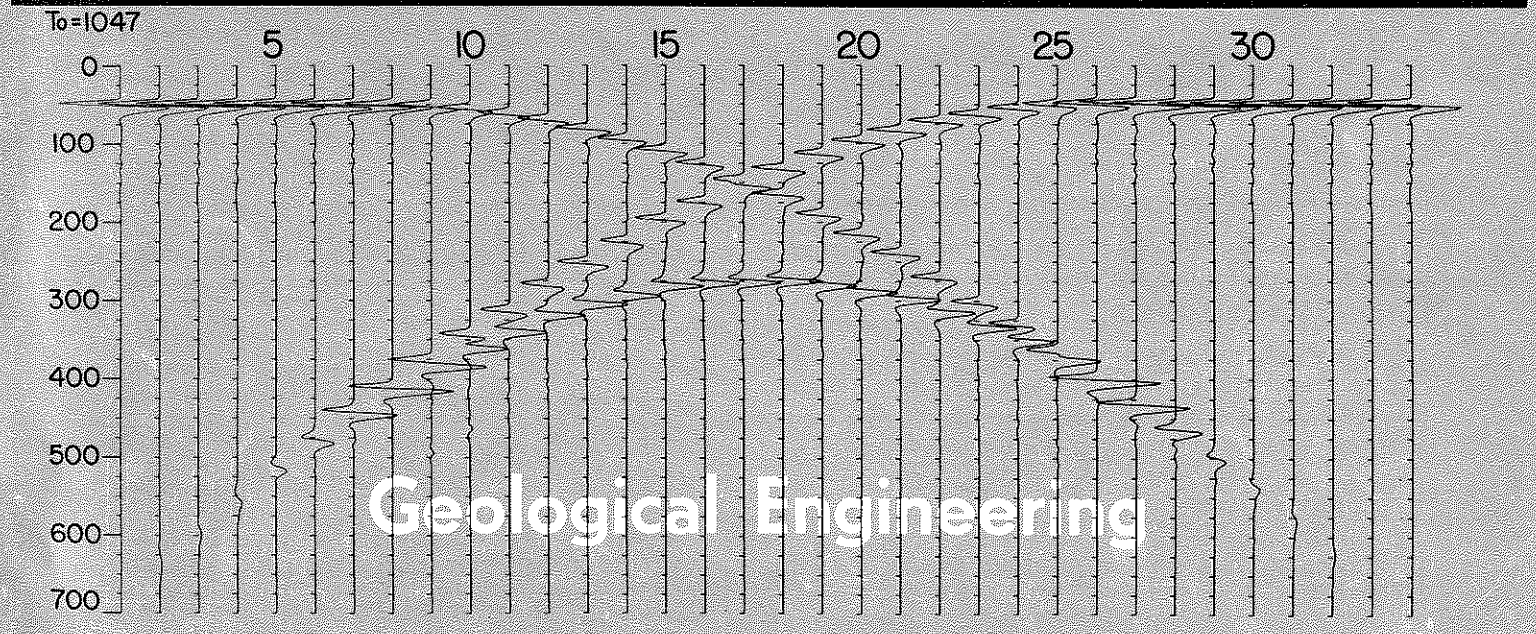
MINES

Magazine

June, 1970







THE MINES MAGAZINE
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Calendar

Due to the remodeling of Guggenheim Hall, the ALUMNI OFFICES will be located in the New Gym, Room 307, for the next several months. The phone number will be the same.

9th International Symposium, Techniques for Decision Making in the Mineral Industry, sponsored by CIM, McGill University and Ecole Polytechnique, Montreal, Canada, June 15-19.

Convention of Wyo. Mining Assn., Jackson Lake Lodge, Jackson, Wyo., June 18-20.

AAPG-SEPM Annual Meeting, Calgary, Alberta, Canada, June 22-24.

CSM Alumni Luncheon, during AAPG Annual Meeting, Calgary Petroleum Club, June 23.

78th Annual Meeting of ASEE, Ohio State University, Columbus, Ohio, June 22-25.

North American Materials Exposition, sponsored by ASTM, Royal York Hotel, Toronto, Canada, June 22-25.

1970 Western Resources Conference, sponsored by Colorado School of Mines, C.U., C.S.U., and D.U., at University of Denver, July 8-10.

South African Tunnelling Conference, University of Witwatersrand, Johannesburg, July 21-24.

Symposium on Nuclear Power, United Nations Headquarters, New York, N. Y., Aug. 10-14.

2nd Inter-American Conference on Materials Technology, Mexico City, Aug. 24-27.

Symposium on Advanced Experimental Techniques in the Mechanics of Materials, El Tropicano Hotel, San Antonio, Tex., Sept. 9-11.

Wyoming Geological Association Symposium and Field Trip, Casper, Wyo., Sept. 21-23.

1970 Mining Convention, sponsored by American Mining Congress, Hilton Hotel and Brown Palace, Denver, Colo., Sept. 27-30.

52nd ASM Materials Engineering Congress and Exposition, Cleveland, Ohio, Oct. 19-22.

SME Fall Meeting and AIME World Lead Zinc Symposium, Kiel Auditorium, St. Louis, Mo., Oct. 21-23.

The MINES Magazine

Volume 60 June, 1970 Number 6

Front Cover

The front cover of this issue of MINES Magazine is Figure 2 in Fred J. Hilterman's article (see pages 11 and 12) entitled "Three-Dimensional Seismic Modeling." It is the calculated (top) and observed (bottom) record sections of a syncline model. The small circles represent the spatial location of both the energy source and detector for individual shots. The coordinate dimensions in the sketch are directly proportional to each other so distance can be approximated by the shotpoint locations.

Features

Departments

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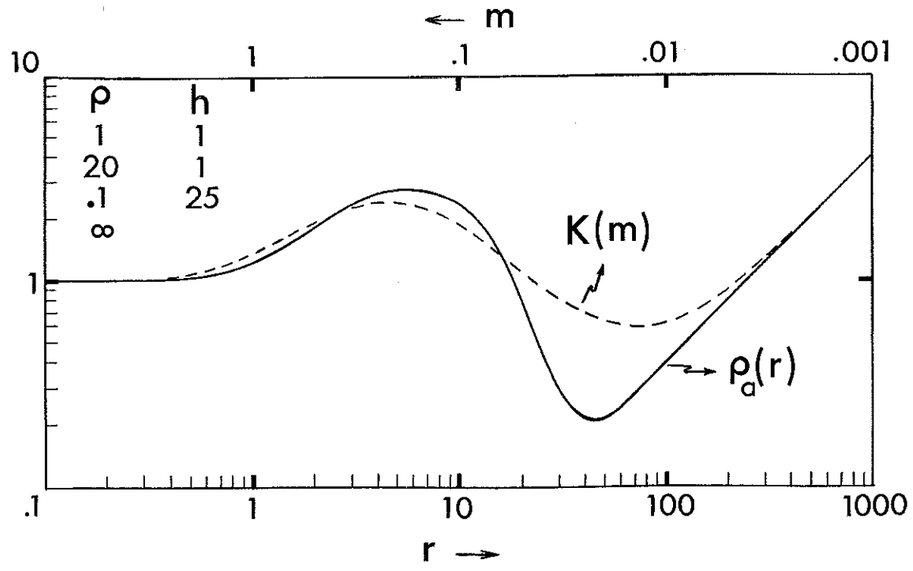


fig 1. Resistivity and Stefanesco functions for the same section.

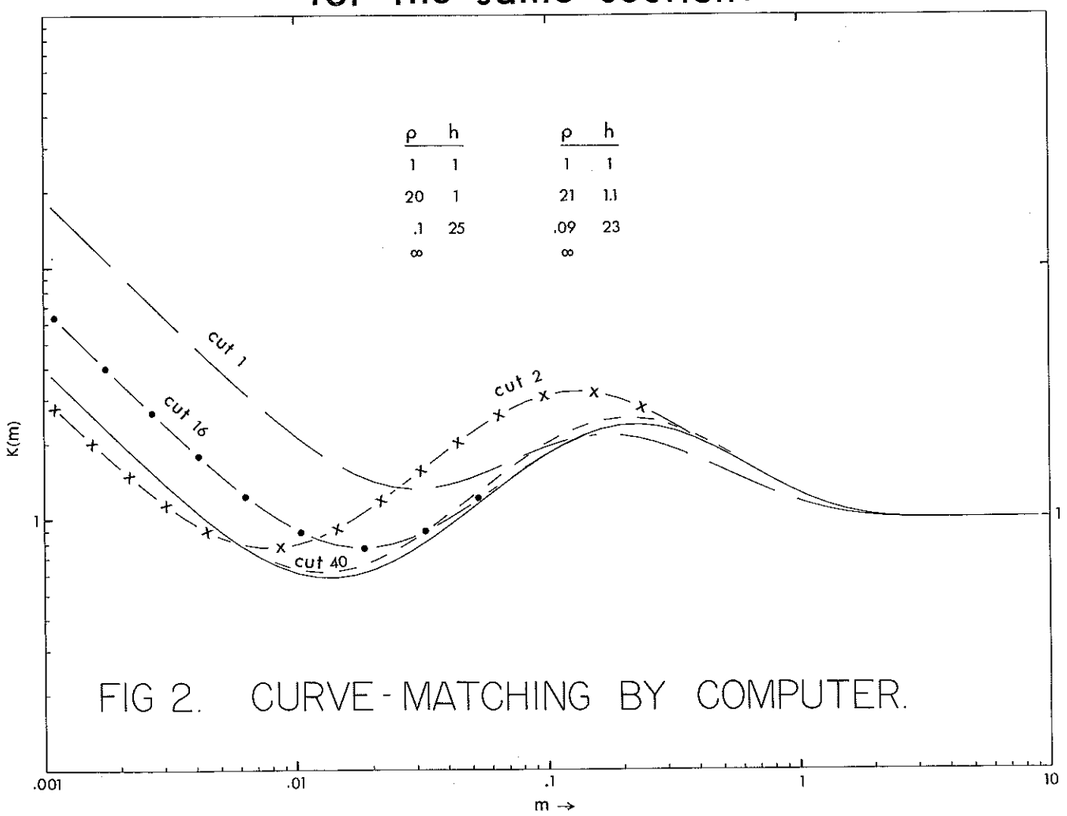


FIG 2. CURVE-MATCHING BY COMPUTER.

Computer-Assisted Interpretation Of Vertical Electrical Soundings

By Christian M. Crous

WHEN a direct electric current is introduced at the surface of a layered earth, the resulting potential field is influenced by the electrical properties of the subsurface layers present. By increasing the distance between an observation point and the point where the current is introduced, it is possible to detect the influence of progressively deeper layers on the potential field.

1. Verticle Electrical Soundings

A vertical electrical sounding (V.E.S.) curve is obtained by plotting a variable depending on an observed potential difference, current and measuring configuration (the inter-relationship is termed "apparent resistivity"), versus the electrode-separation distance r, for increasing distances r. This plot is usually done on a bi-logarithmic scale.

On a curve of this nature, it is possible to distinguish the effect of the successively deeper layers on specific parts of the curve. In most cases, experienced interpreters can also make good estimates of the **true** electrical resistivity and thicknesses of layers present in the subsurface.

This process of determining the thickness—and resistivity parameters constitutes the **interpretation** of a V.E.S.-curve. In the past, interpretation has been done almost exclusively by matching observed V.E.S.-curves to curves calculated for given true-resistivity and thickness-parameters. Theoretically calculated curves are available in the form of master-curve albums. These albums contain limited numbers of combinations of resistivities and thicknesses and in particular very few four-layer or more-layer geo-electric models.

Since an observed V.E.S.-curve so often does not match any of the available master-curves, the need for a fast, inexpensive method of interpretation becomes very obvious.

2. The Stefanesco Function

Stefanesco and others (1930) derived an expression for the apparent-resistivity/distance relationship for a particular electrode-configuration (the Schlumberger configuration.)

$$\frac{\rho_a(r)}{\rho_1} = r^2 \int_0^\infty K(m)\ m\ J_1(mr)\ dm \qquad (1)$$

where

$\rho_a(r)$ = the V.E.S.-curve

ρ_1 = true resistivity of the surface layer

K(m) = the Stefanesco function or "kernel" (Slichter, 1933)

J_1 = the first order Bessel function of the first kind

Stefanesco showed that the function K(m) contains **all** the information about the geo-electric section, and is furthermore free from any effects of the electrode-configuration used to obtain the V.E.S.-curve. These properties make the Stefanesco function very attractive for computer interpretation.

A further consideration is that a very efficient computational technique for K(m) exists (Sunde, 1949.) Computer calculation of K(m) can be done in less than one-tenth the time of the corresponding V.E.S.-curve.

In **Fig. 1** the V.E.S.-curve for the geo-electric section indicated is presented in the usual way, together with the corresponding K(m)-curve. The latter is presented with its independent variable, m, increasing to the left. Resistivities indicated are in ohm-meters, thicknesses in meters. From this figure we see that the Stefanesco function resembles the Schlumberger V.E.S.-curve in shape, and has exactly the same asymptotes.

Since the Stefanesco function cannot be measured in the field, it has to be obtained from the V.E.S.-curve.

By Hankel-transformation of eq. (1), the following relationship results:

$$K(m) = \int_0^\infty \left[\frac{\rho_a(r)}{\rho_1} - 1\right] J_1(mr)\ dr \qquad (2)$$

When the resistivity function is defined over a wide enough range of r, this expression is adaptable to numerical intergration techniques. An approach of polynomial approximation of the integrand proved very satisfactory. (For a test case, numercially determined values were to within .08 per cent of the theoretical values.)

3. Computer Interpretation Procedure.

Computer interpretation is done in the following sequence:

a) Find the field Kf(m) by Hankel transformation of the field V.E.S.-curve.

b) For a first rough "cut" at interpretation, calculate the Kc(m), compare with the field curve. A measure of the difference between the two curves is

$$E_{rms} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left[Kf(m_i) - Kc(m_i)\right]^2}$$

Where N = the number of the points representing both functions Kf(m) and Kc(m)

(Continued on page 6)

About the Author

CHRISTIAN MAURITZ CROUS graduated in 1962 from the University of Pretoria, South Africa. He holds a B.Sc. degree in Mathematics, Physics and Geology.

From 1963-1968 he was employed by the S.A. Council for Scientific and Industrial Research in its Geophysics Section. During this time he was actively engaged in deep resistivity studies to delineate regional structure for oil.

Since June, 1968, he has been attending the Colorado School of Mines, pursuing a M.Sc. degree in Geophysics. He intends to return to South Africa to work for the Southern Oil Exploration Corp. of S.A., which has recently started an extensive oil exploration program.

c) (i) change each of the resistivity and thickness-parameters in turn by increasing it a small amount.

(ii) Calculate the new K(m) for each change, find the new error E'rms. For each parameter, define

$$dE = E'rms - Erms$$

d) The quantity dE now shows the direction in which to change that particular parameter to bring the two curves closer together.

e) Change all parameters to define a new "cut." Changes are proportional to the total error Erms, direction of change indicated by dE's.

f) Repeat procedure from step (b) on.

g) When the quantity Erms in (b) is small enough, the set of parameters in use at that stage can be taken as the interpretation.

An indication of how good the interpretation is can be found in the value of Erms, and a quantity

$$S = \frac{1}{L \cdot E_{rms}} \sum_{i=1}^{L} dE_i$$

for an L-layer case. This quantity S indicates how "sensitive"
the curve is to further small changes in parameters.

Experience so far shows that a good interpretation will have

Erms = .01 to .02 **or less.**
and S = .03 to .05 **or more.**

In **Fig. 2,** the results of one such an interpretation are shown. The "field" curve was taken from a master-curve album, and therefore has known parameters (left-hand group). The other curves are the first and second cut, an intermediate cut, and final cut (after 40 interpretations, two minutes computing time). The machine-interpretation parameters are also shown for comparison.

The limited experience so far obtained with this approach to interpretation shows that good-quality date are of the greatest importance. When a poorly determined field-curve is presented for interpretation, the program tries to match every infection (due to "noise") by inserting another layer into the section-model.

Based on his knowledge of the possible geologic section the final judgment of whether the interpretation is acceptable lies with the interpreter.

A Second Piece of Pie, Please

I went on a diet
My wife said "to try it."
Then she bought a bike,
A house-broken critter,
To make me look fitter—
A man she could like.

At night I would ride it
But wanted to hide it.
I lost pounds and pounds,
As I'd pedal up and around
High in our attic.

My wife was ecstatic,
Then women began me to hound.

The bike is now gone,
The skimpy meals, too.
I eat and I eat,
And to wifie I'm true.

—Pearl Anoe

HUMPHREY SPEAKER AT ASEE MEETING

A speech by former Vice-President Hubert H. Humphrey will be a highlight of the 78th Annual Meeting and Conferences of the American Society for Engineering Education, and leading professional organization in higher education in engineering, at the Ohio State University, Columbus, June 22-25, 1970.

Mr. Humphrey was invited as the fifth annual Distinguished Lecturer of the Society. The Distinguished Lectureship Award, sponsored by the Dow Chemical Co., is given to an outstanding leader to speak at the ASEE Annual Meeting on a subject related to engineering education.

The former Vice-President, a member of the Board of the Encyclopaedia Britannica, will address the gathering of engineering educators, engineers, industry and government representatives, and other interested attendees on Monday afternoon (June 22). No other events are scheduled at that time.

This year the ASEE Annual Meeting and Conferences will feature the topic of Information Processes for Engineering Education—the first time a single subject will be explored in depth at such a meeting.

Dr. John J. McKetta, executive vice chancellor, University of Texas System, will be the keynote speaker, presenting the engineering educator's challenge to the information community Tuesday morning at a plenary session for all conferees.

An educator and chemical engineer respected by both students and colleagues, Dr. McKetta won the national W. K. Lewis Award in 1969 for his efforts toward engineering education excellence. He also finds time to be active in the Engineers' Council for Professional Development, Engineers Joint Council, and ASEE. He co-authored a ten-volume reference on "Advances in Petrochemicals and Refining," which has been translated into nine languages.

Other features of the four-day meeting will be tutorials and demonstrations, which will show or imply wide applications of information processes in engineering classrooms and laboratories. Films on aspects of information processes and guidance will be run continuously throughout the week. The Educational Research and Methods Division will present effective teaching workshops on innovative teaching methods and devices. Of special interest to new faculty members will be three open houses.

The 26 Divisions and the committees with interest in specific areas of engineering will hold meetings, workshops, and conferences on topics related to information processes and other current concerns in teaching. Some interesting topics are the metric system, ROTC in the colleges, industry's demand for experimental engineers, fluid power, systems dynamics, and many others.

The Engineering College Administrative Council will hold several deans' workshops, as well as a general session on program costing and resource allocation. The Engineering College Research Council will highlight computers in education and computer costing. The Technical Institute Administrative Council will hold a workshop on administrative decision and control.

Another highlight of the ASEE Annual Meeting and Conferences is the Eight Annual Exhibit of Educational Resources in Engineering. Exhibitors are keeping the topic of Information Processes in mind, and many will feature the latest hardware and software as well as other teaching aids of special interest to engineering educators.

Programs and registration forms for the 78th Annual Meeting and Conferences are available from the Assistant Secretary, ASEE, Suite 400, One Dupont Circle, Washington, D. C. 20036.

Effect of Subsurface Geologic Structure In Electromagnetic Induction Prospecting

By Richard G. Geyer

ONLY for relatively few geologic configurations has the effect of subsurface geometry on the electromagnetic field been studied. Specifically, only cases of horizontally or vertically divided regions of contracting electrical conductivities (i.e., flat-lying geological horizons or vertical faults) have been solved quite generally mathematically. Recently, Obukhov (1962, 1965, 1968), Dmitriev (1965, 1969), and Feinberg (1961) have outlined mathematical approaches for studying the effect of various types of irregularities in the surface of an insulating basement on the magnetotelluric field observed at the earth's surface. Mann (1964) outlines an approach for a basement surface which is sinusoidal in shape.

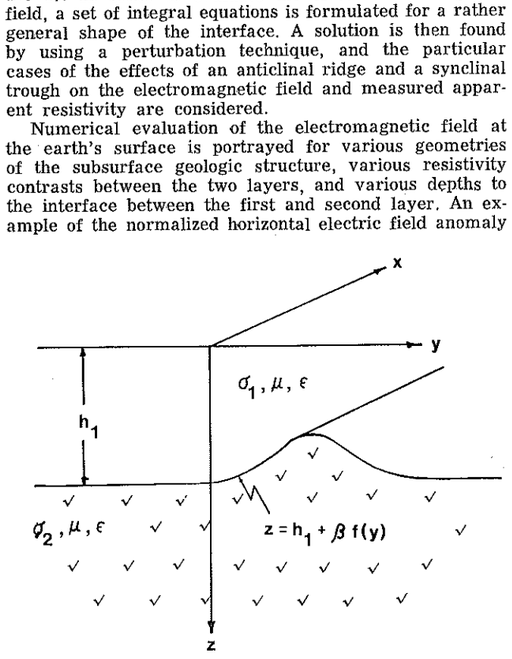
The study of the effect of an irregular subsurface horizon should yield insight into the effect of terrain on electromagnetic field data. It may also be of use in searching for subsurface anticlinal structures and stratigraphic traps in petroleum exploration (or dike-like features in mineral exploration), and for given resistivity contrasts, such a study may help in the determination of the geometry of the buried structure.

In this study, the earth is modeled by two conductive layers which are joined at a nonplanar interface (see **Figure 1**). In order to evaluate the electric and magnetic field, a set of integral equations is formulated for a rather general shape of the interface. A solution is then found by using a perturbation technique, and the particular cases of the effects of an anticlinal ridge and a synclinal trough on the electromagnetic field and measured apparent resistivity are considered.

Numerical evaluation of the electromagnetic field at the earth's surface is portrayed for various geometries of the subsurface geologic structure, various resistivity contrasts between the two layers, and various depths to the interface between the first and second layer. An example of the normalized horizontal electric field anomaly (normalized by what the horizontal electric field would be if no subsurface structure were present) over a buried triangular-shaped ridge is illustrated in **Figure 2.**

When the ratio of the wavelength of the electromagnetic field to the width of the resistant ridge is much greater than unity, the horizontal electric field increases over that ridge. On the other hand, when the wavelength of the electromagnetic field is less than the width of a resistant anticlinal ridge, the horizontal electric field decreases over the ridge. If the resistivity contrast, electric field anomaly, and first-layer thickness are known, the depth to the crest of an anticlinal ridge may also be ascertained. In summary, with the aid of electric field master curves, numerous inferences can be made with regard to resistivity contrasts, the geometry of the subsurface geologic structure, and the depth of burial of the structure.

Although this research has concentrated on subsurface geologic structure, the same approach might be used for mapping surface terrain with electromagnetic inductive methods. Moreover, the same procedure may be applied to the problem of a multi-layered earth with arbitrary interfaces between all layers. Root zones of batholithic intrusions may be modeled, and the nature of the mantle-crust boundary may be ascertained. In conclusion, many



NONPLANAR REGION OF CONTRASTING CONDUCTIVITY

FIGURE 1

(σ_1 is the electrical conductivity of the first layer, σ_2 is the electrical conductivity of the second layer, μ is the magnetic permeability, and ϵ is the dielectric constant.)

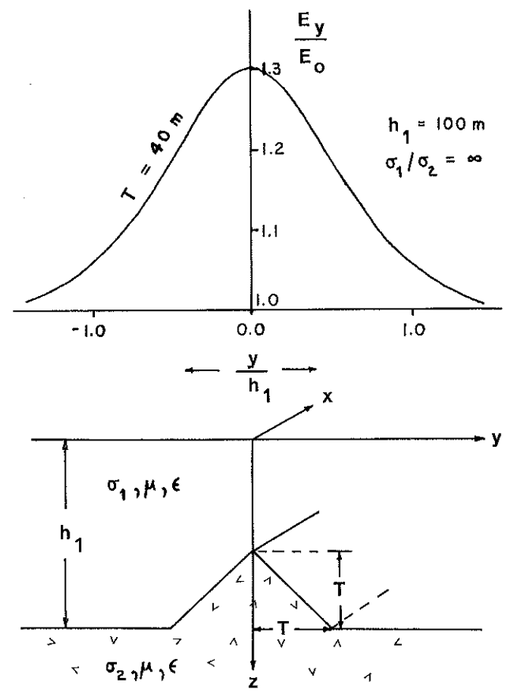


FIGURE 2

(Normalized electric field anomaly over buried triangular-shaped ridge when the real radian wavelength is 100 times the first-layer thickness.)

structural-stratigraphic relationships may be delineated by examination of the electromagnetic field response at the earth's surface.

About the Author

Richard G. Geyer was born in Lansing, Michigan in 1944. He received the B.S. degree in geology from Michigan State University in 1966 and the Ph.D. degree from Colorado School of Mines in 1970. While at Michigan State University, he was a member of the Honor College, Phi Eta Sigma, Phi Kappa Phi, and Tau Sigma, and he held the Mobil Oil Company fellowship, the California company scholarship, and several NSF undergradute research stipends.

As an undergraduate he also worked as an assistant geophysicist for the McClure Oil Company. During the summer of 1966 he was employed by Chevron Oil Co. in Lafayette, La. for seismic attenuation and velocity analysis studies.

At Colorado School of Mines he held a N.D.E.A. predoctoral fellowship and the Texas Oil Company fellowship. During the 1968-1969 academic year, he was a teaching assistant at Colorado School of Mines.

In 1970 he will join the Geologic Research Center of the King Resources Company in Denver as a research geophysicist in gravity, magnetic, and electrical exploration. Professional membership includes S.E.G., A.G.U., and E.A.E.G.

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As It Looks to Me

COOL RHETORIC

IN his recent press conference President Nixon suggested that when the conditions are out of hand, the rhetoric should be cool. In the past I may have bruised some feelings with my statements, but now I will give the emotions a chance to cool. This does not mean that my position has changed or that I feel that I am wrong. It is a fact that I do not understand the present generation of college students as exemplified by those who are willing to riot, destroy property, and burn buildings.

MINES

We have been fortunate here at MINES in that there has been no disturbances and although one was threatened during the Federal Inspection held on Monday nothing came of it. The Annual Federal Inspection of the ROTC went off without incident although the field was closed to the general public due to the threat of demonstrators arriving from near-by schools. It is only fair to say that the situation at Mines has been handled wisely for we have had some agitators on the campus but not in the number that are found on other campuses.

Perhaps the best statement of these facts are contained in the editorial from the May 14 issue of the Jefferson Sentinel, a weekly paper published in Lakewood and reporting the news of Jefferson County.

OREDIGGERS STICK TO STUDIES

The headlines were made at the University of Colorado and the University of Denver.

DU ordered quick and efficient steps to rid its campus of unruly demonstrators. CU officials knuckled under the demands of the militant minority.

Thus, it was hardly noticed that here in Jefferson County, at the Colorado School of Mines, it was business as usual without a whisper of dissent. Students there even ignored a planned protest at an ROTC review Monday. Although some agitators came in from other schools, the Miners paid no attention.

The Orediggers like to raise a little hell now and then, but it is never forgotten that the students are there for only one thing—to get an education.

We believe the Mines students, faculty and administration are to be commended.

THE OREDIGGER PROBLEM

There has been a change in composition and attitude of the Orediger since Jack Yench resigned as editor. I am quite sure that this has been evident to those Alumni who subscribed to the Orediger during the recent drive for subscriptions. The paper is not as exciting as it was before, but certainly it is doing a better job of recording local news in Golden rather than headlining the problems of other campuses.

STUDIES

One of the problems at Mines which prevents wholehearted participation in demonstrations is the work-load imposed by the requirements for completion of a semester of work. In an engineering school, each course is a step to the one which follows, and therefore if you fail a freshman or sophomore course, you can only expect to be in particular difficulty as you advance to your junior and senior year. How much this work-load has contributed to the quietness of the campus is not clear but it certainly has been a factor. Another factor may well have been that the high school graduate who is dedicated to engineering is serious about his life's work and therefore accepts his four years in engineering schooling as a prelude to the lifetime of service and satisfaction.

POLITICAL ACTIVITY AND STUDENT VISITS

This is an activity of which I approve wholeheartedly, provided it is carried out in a manner that will accomplish its purpose. Political activities should be an individual commitment and should not involve the university or institution as such. To ask the institution to commit itself to a particular political philosophy is not correct, for no single philosophy will represent the political beliefs of the thousands of students who attend that particular institution.

Visits by students to individual homes is in order, but again this must be done in a manner which will enhance the prestige of the student and not merely infuriate the homeowner. Believe me, the destruction of buildings on campuses has hit the homeowner where it hurts, i.e. the pocketbook, but he may still grant an interview with the student who knocks at his front door. However this should be a dialogue, repeat dialogue, and not a tirade directed at the beliefs of the homeowner with whom the student may find little basis for a comfortable discussion. Over the past several years, the practice has been to disagree loudly and vociferously with anyone who did not accept, in his prepared speech, the format that was desired by the students. As a result, there has not been the dialogue that all are interested in holding.

In spite of these thoughts, I think it is a wonderful idea and I can only hope that the students follow it up after careful preparation and this is to include a willingness to accept the "square" beliefs of those with whom they are trying to communicate.

OF DRUGS AND SUCH

Joseph Stalin in 1940 stated, "By making readily available drugs of various kinds, by giving alcohol to the teenager, by praising his wildness, by strangling him with sex literature and advertising . . . psychopolitical preparation can create the necessary attitude of chaos, idleness, worthlessness."—Quoted from U. S. Representative Ed Foreman, New Mexico, Newsletter, March, 1970.

—W. W. Fertig

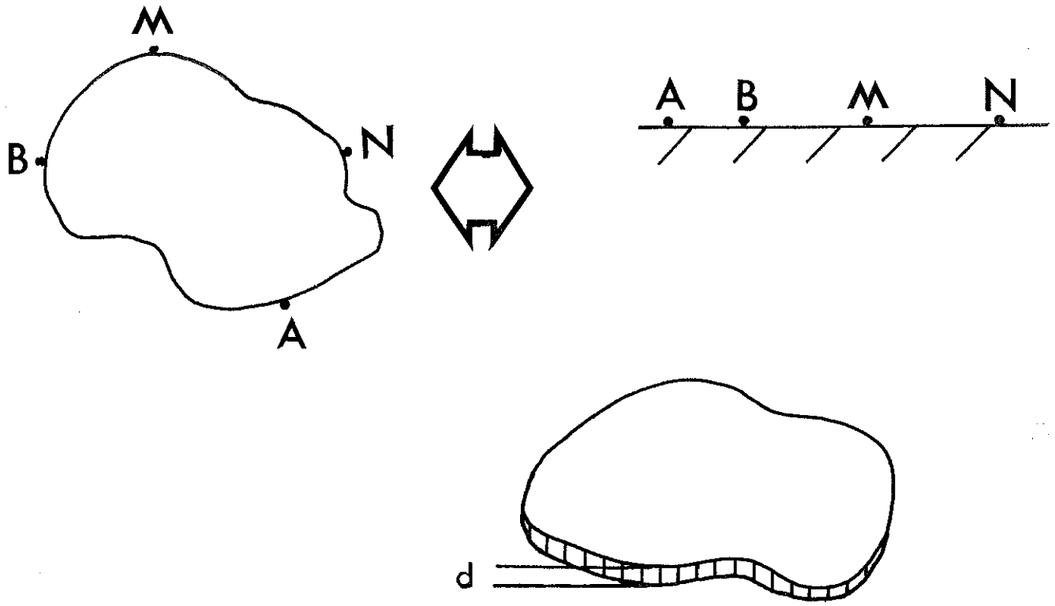

Figure 1.

Ohm's Law and Rock Samples: A Plane Complex Convenience

By Glynn Cress

IN 1958, L. J. van der Pauw of Phillips Research Laboratories, Endoven, The Netherlands, published a research report Vol. 13. The publication describes a method of determining the resisitivity of semiconductor discs of otherwise arbitrary shape.

The method has been used on core samples from wells drilled in several geothermal areas of the Taupo volcanic region of New Zealand. Resistivities ranging from 6 ohm-meters on a clay sample to 243 ohm-meters on a tight greenstone sample were determined. Random samples, on which a resistivity determination had already been made, were returned to the group which had not had a resistivity measurement. These repeated determinations of resistivity were used to infer reliability information. Many samples were measured as many as four times, with the resistivity ranging from .7% to 30% from the lowest to highest value. For all cases, when the highest value exceeded the lowest value by more than 15%, the sample observed to be macroscopically anisotropic.

The method requires one measurement of distance—the disc thickness — and two voltage and two current measurements.

About the Author

GLYNN DALE CRESS, whose home is in Granby, Colo., is a graduate student in Geophysical Engineering. In 1957 he earned a B.S. degree in Physics from the University of Denver and in 1965 received an M.A. degree in Science Teaching from Western State College. A student member of S.E.G., C.W.A.S., I.E.E.E. and A.G.U., Mr. Cress expects to teach after graduation from the Colorado School of Mines.

A development of the mathematics upon which the method is based will help explain the limitations and assumptions of the method.

Begin as in **Figure 1** with the plane uniform half plane. Place the boundary of the half plane 4 electrodes. Through 2 adjacent electrodes—call them A and B—force a current I to flow. Use the other two—M and N—as potential electrodes. The potential at M due to the current source at B is $\frac{-\rho I}{\pi d} * \mathrm{Ln}(BM)$ were p is resistivity, d is sample

thickness, Ln is the natural log, I is source current, BM is the distance from B to M. The potential at N due to the source is $\frac{-pI}{\pi d} * Ln(BN)$. Subtract these two expressions to give the potential difference between M and N: $V_B=(-pI/\pi d)Ln(BM/BN)$.

A repetition of the procedure for source A yields: $V_A=(-pI/\pi d)Ln(AN/AM)$. Add these two expressions to get the total potential difference between M and N due to both sources, recalling that the current at A is the negative of that at B: $V_B+V_A=(-pI/\pi d)Ln(BM/BN)(AN/AM)$. Now solve for the log term and take the anti-log: $EXP(-\pi dR_1/p)=(BM/BN)(AN/AM)$, where $R_1=(V_B+V_A)/I$.

If one now permutes the electrodes one place and repeats the process, the expression $EXP(-\pi dR_2/p)=(MN/BN)(AB/AM)$ is obtained, where R_2 is the potential difference between the new potential electrodes divided by the current through the new current electrodes. Now add these last two expressions to give: $EXP(-\pi dR_1p)+EXP(-\pi dR_2/p)=(BM/BN)(AN/AM)+(MN/BN)(AB/AM)$. The expression on the right side of the equal sign adds to 1. This last expression is a two-dimensional Ohm's Law.

The process of conformal mapping in complex variables allows geometric shapes in one complex plane to be mapped into another shape in another complex plane. Ohm's Law has been derived for an indefinite half plane. The Swartz-Christhoffel transformation can be used to map an infinite half plane into a closed polygon. An arbitrary closed figure can be approximated as closely as one desires by increasing the number of sides. Fortunately the transformation need not be carried out. One needs only to show that the transformation exists and that resistivity is invariant under the transformation. The transform is known to exist and the invariance is shown to hold by contour integration in the two planes. Intuitively, resistivity should be a property of the material, and not depend on the geometry of the sample.

Now we can use the form of Ohm's Law derived on the half plane, to determine the resistivity of our plane sample. Unfortunately, the equation $EXP(-\pi dR_1/p)+EXP(-\pi dR_2/p)=1$ cannot be solved for p. Van der Pauw suggests curve matching; however, if accuracies of ± 1 ohm-meter are sufficient, this expression is usually sufficient: $p=1/[2Ln(.5)](dR_1+dR_2)$. If this is not accurate enough, an iteration program can easily be written which can be expected to determine the resistivity of 100 samples to $\pm .01$ ohm-meters in about 30 seconds on a digital computer.

The mathematical model tells us that the sample must be thin (the thickness should be no more than about 1/5 the diameter) and macroscopically homogeneous.

The method is easy, reliable, fast and inexpensive. The electrodes can be attached to the sample with a rubber band and a paper clip. The permutation is accomplished by manually switching the electrode wires between current source and voltmeter.

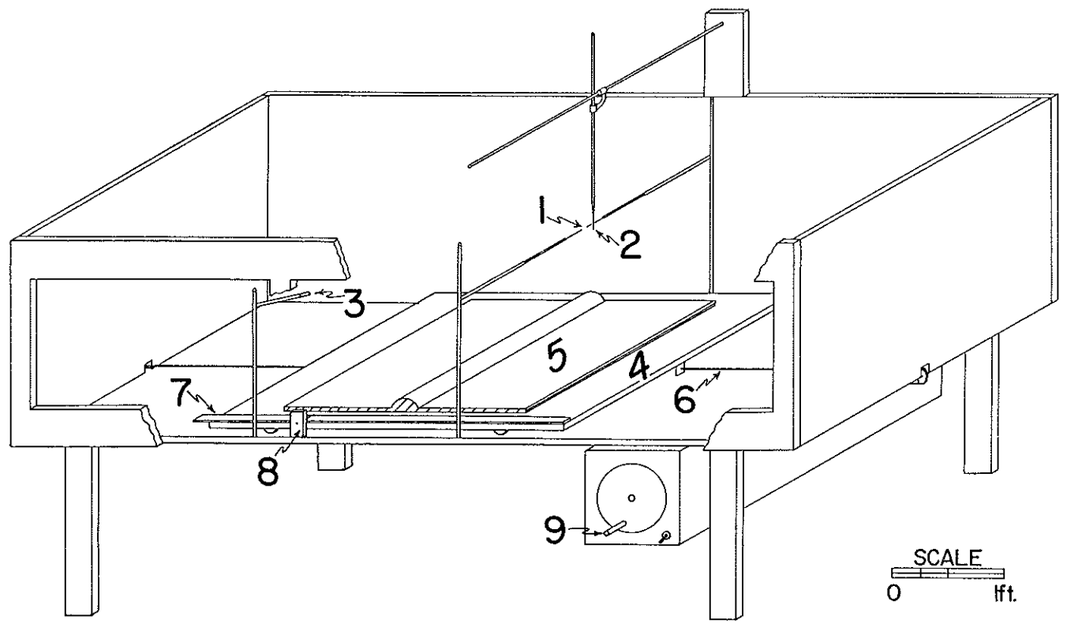

FIG. 1. Model. The numbers refer to

1. Spark gap.
2. Eighth-inch condenser microphone (detector).
3. Half-inch condenser microphone (reference).
4. Horizontally movable platform
5. Model of geologic structure.
6. Platform cable.
7. Meter stick.
8. Horizontal reference point.
9. Platform crank.

Three-Dimensional Seismic Modeling

By Fred J. Hilterman

INTRODUCTION

THE seismic reflection technique is a useful geophysical tool for outlining subsurface geologic structures. The structures are determined by observing the time it takes for energy from a near-surface source to travel to a geologic discontinuity and return to a detector on the surface. In an effort to gain additional stratigraphic information, such as porosity, it is necessary to study not only the traveltimes to the discontinuing, but also the shape of the returning energy. However, if the boundary is nonplanar, the effect of geometric curvature should be taken into consideration when analyzing the change in pulse shape.

In the present study, a small-scale experiment was designed which emphasized the reflected and diffracted events from an irregular boundary. In addition, a computer modeling technique for simulating the experimental model was developed. The time-section data generated with the computer were compared to the experimental time sections in order to verify the mathematical modeling technique. The mathematical model was a far-field approximation of a numerical technique suggested by Mitzner (1967).

EXPERIMENTAL MODEL

The first phase, the collection of the experimental data, was conducted using the coffin-like structure shown in **Figure 1.** The equipment was designed to satisfy the model-prototype (earth) ratios of 1 inch is equivalent to 1000 feet and 1 microsecond is equivalent to 1 millisecond.

An electric spark and an eighth-inch condenser microphone simulated the seismic energy source and detector array. The eighth-inch microphone corresponds to a 125-foot detector pattern.

There are two viewing windows in the front of the enclosure. The right-hand window contains a glass panel which reduces air turbulence when data are being collected. Through the left-hand window, the geologic models, such as Number 5, are placed on the movable platform. The geologic models were constructed out of wood or heavy paper. After placing the models on the platform, the microphone and source were vertically adjusted to simulate the desired depth to the geologic structure. The positions of the microphone and source were fixed and successive shotpoint locations were obtained by translation of the movable platform.

As the geologic models were incrementally passed beneath the source and detector, a single trace for each shotpoint was recorded by an oscilloscope camera. The traces were then manually digitized and plotted as a time record section. These record sections constituted the experimental portion of the study.

TYPICAL RECORD SECTIONS

In the isometric sketch on Front Cover, **Figure 2,** the small circles represent the spatial location of both the en-

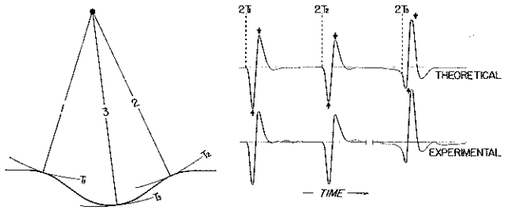

FIG. 3. Raypath geometry and trace analysis for shotpoint 15 of syncline model.

ergy source and detector for individual shots. For example, when the source and detector were located at position 15, the time function shown as trace 15 in the experimental record section was observed.

The coordinate dimensions in the sketch are directly proportional to each other so distance can be approximated by the shotpoint locations, which are 400 feet apart in the earth prototype. Absolute traveltime is obtained by adding the T_o time shift to the section time scale (both times are in milliseconds for the prototype).

There are three major events in the record sections. With the aid of **Figure 3,** the events in **Figure 2** are more easily identified. The flat event in the upper left-hand corner of the record section which continues downward toward the right is a reflection from the left flank of the syncline. The second event starting in the upper right-hand side is similar to the first event, except it is a reflection from the right flank of the model. Finally, the third event, which is symmetric and convex upward, is a diffraction from the bottom of the syncline.

About the Author

Fred J. Hilterman received the degrees of Geophysical Engineer in 1963 and Doctor of Philosophy (Geophysics) in 1970 from the Colorado School of Mines. From 1963-1966, he was employed by Mobil Oil Corporation and after finishing his Ph.D. he has returned to Mobil working in seismic exploration and data-processing. He is a member of the SEG and EAEG.

As shown in **Figure 3,** the diffraction from the bottom of the syncline is approximately 90° out of phase with respect to the reflected pulse from the side of the flank. This single example of the phase change due to concave curvature illustrates the care that must be exercised when outlining certain portions of geologic structures.

CONCLUSIONS

The agreement between the mathematical and experimental model sections demonstrates that the mathematical modeling technique can accurately profile a three-dimensional model. The mathematical technique is especially suitable for subsequent interpretation since the boundary segments can be analyzed individually and the effect of curvature can be taken into consideration.

It is realized that neither the mathematical nor the experimental model is an exact representation of the earth prototype, but the insight gained from the reflection-diffraction complexes of the model sections is extremely useful in identifying events which would otherwise be considered unwanted noise.

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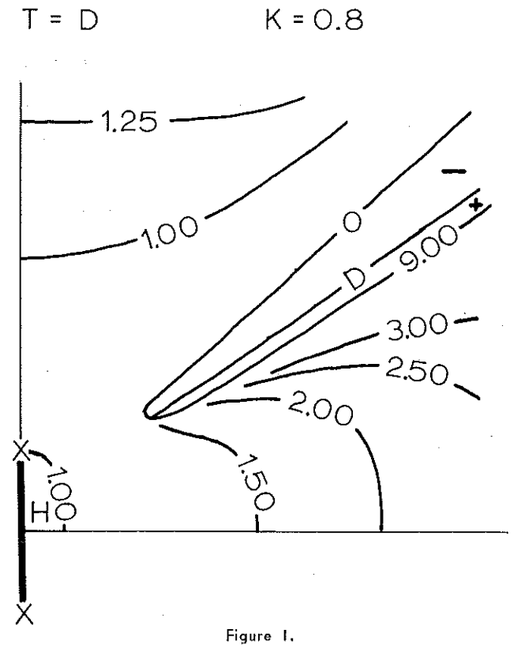


Figure 1.

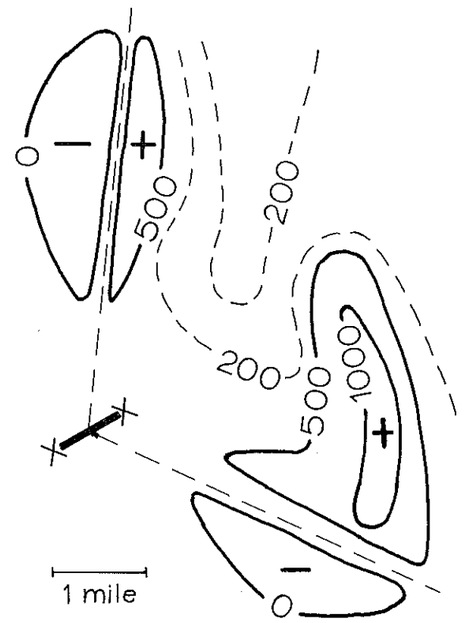


Figure 2.

A Controlled-Source Telluric Current Technique And Its Application to Structural Investigations

By Robert Bernard Furgerson

THERE are considerable difficulties in using the common electrical sounding and profiling techniques are structural investigations. The sounding techniques are eliminated early from consideration because their use is primarily in determining horizontal layering. The profiling techniques usually work well for surveys with small areas, shallow probing depths, and two-dimensional structures, but efficiency breaks down when the investigation covers large areas, involves large probing depths, and contains structures which may be equant rather than two-dimensional. A final problem, especially difficult in the southwestern United States, is high grounding resistance.

In an attempt to overcome these problems, a method termed a controlled-source telluric current technique was proposed. The technique is essentially an equipotential mapping technique much like the telluric and magnetotelluric current techniques it was named after. Like these techniques, it is used to obtain information in one or more quadrants rather than along profiles. The electrode array consists of a stationary current dipole of large dimension (say 1 to 4 km) and a potential dipole of small dimension (say 100 to 500 m). Current in the frequency range of 0.015 to 0.065 Hz is driven through the current electrodes.

At first this array may appear to be merely an azimuthal dipole-dipole array. However, for the current and potential electrode separations to approximate true dipoles, the separation between them should be at least five times the larger of the two. Experience, however, shows that for large current electrode separations, practical current moments of 20,000 to 200,000 amp—m give reliable field strengths for distances up to five or at the most ten times the current electrode separation. Thus most of the stations are taken for array geometries where the array is more properly termed a quadrapole array or a pole-bipole array.

At each recording station measurements are made in two mutually perpendicular directions so that the magnitude and direction of the total electric field can be calculated. Ideally these directions are parallel and perpendicular to the current source, since the map for apparent resistivity in the direction parallel to the source is used in interpretation. There are two other components which may be useful in interpretation and may be measured in a complete survey. The first is the radial component for which the potential electrodes are oriented along the line connecting the centers of the current dipole and potential dipole. The second is the maximal component for which the potential electrodes are oriented in the direction of the maximum electric field observed for a homogeneous earth.

These electric field components are converted to values of apparent resistivity and then contoured. Although the various apparent resistivity maps may in many cases be self-explanatory, the best way to interpret the maps is to study the technique applied to various simple structures. The first structure studied was the case of two horizontal layers. The apparent resistivity map derived from the total electric field vectors has contours which are quite

smooth and roughly elliptical. As may be expected, profiles taken along the principal axis are familiar. The profile along the axis parallel to the source is identical to a polar dipole array. The profile along the axis perpendicular to the source is identical to an equatorial dipole array. As the reflection coefficient decreases from a large positive value, passes through zero, and approaches a large negative value, the gradient of the contours at a specific distance from the source decreases from a positive value, goes through zero, and then increases in negative values. For a constant reflection coefficient, the gradient of the contours decreases as the first layer thickness increases.

Figure 1 shows the parallel field apparent resistivity normalized by the first layer resistivity for the case where the first layer thickness equals the source length and the reflection coefficient equals 0.8. The profile along the principal axes are identical to those for the total field apparent resistivity, but with this the similarity ends. These maps are extremely more complex than those for the total field; discontinuities, zeros, and negatives are present, whereas the total field maps are quite smooth and all positive. The region of large positive values and the region of negative values bounded by the zero contour have a very interesting relationship. For thicknesses greater than one-half the source length, these regions start at a distance for the center of the source approximately equal to the first layer thickness. The region of large positive values and the region of negatives shrink to zero as the reflection coefficient goes to zero and exchange locations when the reflection coefficient changes sign. Thus, by observing the geometry of the discontinuity, the region of large positive values, and the region of negatives, the interpreter can determine the sign of the reflection coefficient and the approximate first layer thickness.

Figure 2 shows an example of an actual field survey made in the Darwin Hills, Inyo County, California. The map is of the parallel field apparent resistivity and is contoured in ohm—m. When this and the total field apparent resistivity map of the area are studied, they suggest the main structure is a semi-infinite plate. This corresponds quite well to the plate of Paleozoic limestones located northeast of the source with its vertical contact nearly perpendicular to the current source and about 1¾ miles from the center of the current source. The resistivity of the highly fractured limestone is about 250 ohm—m and the resistivity of the granodiorite batholith surrounding the limestone plate is about 500 ohm—m. The distance to the region of negatives and large positive region indicate the limestone plate is about 1¼ miles thick. The large high trending north-south and merging with the high associated with the discontinuity is probably the resistive core of a small granodiorite stock which outcrops about two miles to the northwest of the center of the high. The probability that the stock dips steeply to the southeast is thus indicated.

This field example points out many of the advantages of the technique. Since the current electrodes remain stationary, only a few good contact areas need be found. Problems with rugged terrain are minimized because only the two potential electrodes and the relatively short wire connecting them need be moved. A large area can be easily covered (over 25 square miles in the above example). Finally because the current electrodes are stationary, inhomogeneities in resistivity near them tend to effect measurements at different potential locations in a fairly constant manner.

About the Author

Robert B. Furgerson received his B.S. degree in geophysics from the University of California, Riverside, in 1968 where he was graduated with honors. In 1970 he received his M.S. degree in geophysics from the Colorado School of Mines for work in electrical prospecting methods. In the fall of 1970 he will enter the University of California, Riverside, as a Ph.D. candidate, where he intends to do work in Basin-and-Range tectonics and the related ore deposits. He is a member of S.E.G. and the European Association of Exploration Geophysicists.

Dr. Orlo Childs Appointed at Texas Tech

PRESIDENT Orlo E. Childs of the Colorado School of Mines, who resigned at the end of the academic year in June, has been named Vice President for Research at Texas Tech University.

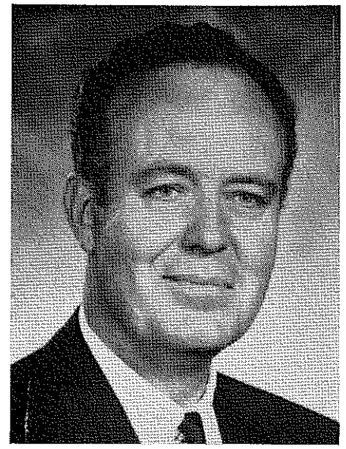
The appointment, to begin July 15, was announced by Dr. Grover E. Murray, president of Texas Tech in Lubbock, Texas.

Dr. Childs will coordinate all research activities and functions for both Texas Tech University and Texas Tech University School of Medicine. The West Texas university, which includes nine schools and colleges and 20,000 students, is conducting extensive research programs. Childs will direct and expand these activities, including securing additional financial support from government, industry, foundations, and private donors.

Dr. Childs will remain at Colorado Mines until June 10, at which time he will go on vacation. On June 20 he will be made an honorary member of the American Association of Petroleum Geologists at that group's annual meeting in Calgary, Canada. He served as president of the AAPG in 1965.

Childs, president of the Colorado School of Mines since 1963, announced his resignation, effective at the end of the school year, at a faculty meeting on Feb. 18. He told faculty members he had made his decision in the fall of 1969, and both he and the Board of Trustees agreed to delay announcing the decision so that there would not be a "lame duck" administration through the entire school year.

At that occasion, he said it is an opportune time for Mines to have new leadership. "An emerging national minerals policy is putting increased emphasis on education in mineral resources," he said. "There are new



Dr. Childs

reactions to the environment in which we live which feed the vitality of the institution and call for a new president to meet the challenges of the future."

During his presidency, the Colorado School of Mines has experienced increases in enrollment, expansion of the graduate school, realignment of the degree program to offer bachelor's, master's, and doctoral degrees in the nine degree-granting departments, increase in faculty, and development of a continuing education program.

Expansion of the physical plant has included the $3 million Cecil H. and Ida Green Graduate and Professional Center now being built. More than $2.4 million to fund the structure was secured from industry, foundations, and private individuals. State funds provided the balance.

Born in Loa, Utah, Mar. 28, 1914, he attended Weber State College, Ogden, Utah, from 1931 to 1933, and then the University of Utah, where he received his bachelor's degree in 1935 and his master of science degree in 1937. He gained his doctorate in geology at the University of Michigan in 1945.

Before coming to Colorado Mines, Dr. Childs spent 13 years as exploration project director for the Phillips Petroleum Co. in Denver. Prior to that, he was an assistant professor at the University of Wyoming, and had taught at Colgate University and other schools. At the time he was named the 11th president of Mines, he was in charge of the U. S. Geological Survey's oceanography program, based in Menlo Park, Calif.

In addition to the American Association of Petrolem Geologists, Childs is a member of the Advisory Council of the Public Land Law Review Commission, past chairman of the Western Region White House Fellows Program, member of the Colorado Fulbright Scholarship Committee, a fellow in the Geological Society of America, charter member of the American Institute of Professional Geologists, and member of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). He was chairman of the AIME Colorado Section in 1968.

Dr. Childs and his wife, the former Elizabeth Swisher, have three children, sons Bradley and Barry, and daughter Elizabeth. Bradley is working part-time at the Minneapolis First National Bank and will attend the Stanford University Graduate School of Business Administration in the Fall. Barry, who is completing his junior year at Wittenberg University, is presently at the University of Exeter, England on a Wittenberg study program. Elizabeth is completing her sophomore year at Golden High School.

How Can We Do a Better Job Of Managing the Environment?

By Gordon J. F. MacDonald

ENVIRONMENT has become one of the key words of our time. After generations of carelessness and indifference, we are beginning to appreciate how closely the quality of our lives is linked to the condition of the world around us. Concern about the environment permeates almost all sectors of society. It is a concern shared by those with greatly differing political views. President Nixon has given environmental programs a high priority. During early 1970, he described his proposed program as "the most comprehensive and costly program in this field ever in the nation's history." Senator Muskie has long seen environment as a key political issue and continues to introduce major legislation protecting and enhancing environmental qualities. There is similar interest at the State levels. For example, in California Governor Reagan in his 1970 State of the State message devoted a major portion to environmental questions. The environmental issue is so important and all the political parties are so aware of the public's interest that what we are now seeing develop is a political contest over who is most concerned about the environment and who can come up with the best programs to maintain or to improve its qualities. In the past, environmental control has been either neglected or treated as a minor political issue, but in the coming years, it is likely to be one of the two or three most significant campaign topics. There are, of course, some who ask why should we concern ourselves immediately with the environment when the crises of the war, civil violence, inflation, and social unrest are so imminent. In part, the answer is that certain changes in the environment are irreversible. Unless actions are taken now, major environmental resources coul'd be altered in such a way that they could never be restored. But there is also another answer and that answer is that the degradation of the environment inflames social and economic problems. The feelings of alienation and discouragement which we find so prevalent today are not independent of the problems of suffocating smog, agitating noise, urban sprawl, endless concrete, and the heat of the cities. Because of these barely perceived yet important connections, environmental problems are more than important. They are fundamental.

Together with all the rhetoric, a number of preliminary but important steps have been taken both in the executive and in the legislative branches of the government which attempt to translate public concern into public action. In his 1970 Environmental Message President Nixon outlined a program designed to deal in a positive way with some of the major problems of air and water pollution. On the Congressional side, a bill sponsored by Senator Henry Jackson established a Council on Environmental Quality and the President signed this bill on the first day of 1970. This Council has the responsibility for developing, for the President, over-all policies in dealing with environmental matters. In addition, the National Environmental Quality Act of 1970 provides a broad statement of how the federal government should view environmental questions. According to this Act, each federal project or program would be examined for its effect on the environment. The evaluation of the environmental impact of individual programs would then guide decisions as to whether the program should be supported. This Act is sure to be only the first of a number of pieces of legislation which Congress will pass and which will influence, in major ways, the environmental health of the nation.

Unity of the Environment

If one examines the actions taken in the environmental field rather than the discussions held, it is clear—for the most part — that these are merely holding skirmishes against the forces of pollution and exploitation. Each problem has been treated in an **ad hoc** way and the strong interactions between various parts of the problem are neglected. Even before the days of Teddy Roosevelt, dedicated conservation groups fought for the preservation of public lands and for the establishment of national parks. Since then, these same groups have fought for the redwoods, for the preservation of the Everglades, against the location of power plants, and against offshore oil drilling. In a sense, the conservation groups provided the front line attempting to hold back potential ravages of technological progress. Such **ad hoc** actions preserved important elements of our environment in the days when there was much land and few people. However, such responses are no longer adequate now that there are many people and not so much land. Freeways, smog, urban sprawl, and the lack of open spaces are not independent nor can they be dealt with without understanding the interactions of the various parts of the environment and of these parts with society.

The isolated action-reaction response to environmental crises is symptomatic of the fundamental problem which we face. We have not used existing institutions nor have we developed new ones to organize our knowledge about the environment and to translate what we know into policy and action. The environment, with its intricate interdependencies, cuts across established institutions and disciplines and raises sensitive questions of value. If we are to manage the environment more effectively, we need to face the key questions of how to obtain an organized knowledge of the environment and how to use that knowledge.

Categorization of Environmental Problems

Before proceeding to discuss what I believe to be a useful approach to certain of these institutional questions, I would like to categorize four different kinds of environmental problems. The categories are not sharp since one kind of environmental problem often blends into another kind just because of the unity of the environment itself. However, in considering possible management methods, it is well to have in mind the various more important problem areas:

1) Many environmental problems result from improper land use or from inadequate consideration of the potential value of the land which is to be altered. For example, the proposed jetport just west of Miami and north of the Everglades, together with the associated transportation corridors, presents a major danger to a unique ecological preserve. Planning for the jetport took into account such variables as density of population, regional transportation needs, and a host of other variables related to transportation, but gave little or inadequate consideration to the dangers to the Everglades National Park. Another kind of unwise land use results when unlimited access to a wilderness area reduces its recreational and wilderness value. Unhappily, the National Park Service by permitting continuous flows of automobiles into Yosemite National Park has changed what used to be one of nature's great wilderness areas into an unpleasant place to visit. Of course, it is not only the wilderness which is affected by the unwise use of land. One needs only to examine the great urban sprawl which is now Los Angeles and its disastrous esthetic consequences to note the importance of proper urban planning. And it is not only esthetic values which are damaged by such unchecked developments. Lives and property are endangered through real estate developments placed in flood plains and along unstable slopes.

2) The second category of environmental problems arises from improper appreciation and use of natural resources. A classic example is the federal government's decision to permit drilling for oil in the Santa Barbara channel. In this case, values associated with the development of the oil resources received appropriate consideration. But those esthetic and recreational values of great importance, not only to the residents of Santa Barbara but to visitors as well, were ignored to a very substantial degree. There are many other examples of what happens when the consequences of how we use our natural resources are not thoroughly identified. For example, dams along the Pacific Coast providing flood control and power are also limiting the amount of sand reaching the beaches of Southern California. Indeed, if present practices are not altered, in twenty or thirty years the ninety or so miles of usable public beach along the Pacific shoreline will decrease by more than one-half and with this decrease—together with the expected increase in population—the one-fourth inch of beach frontage now preserved for each resident of the Pacific States will be reduced to less than one-twentieth of an inch.

3) Historically, man has assumed that the land, water, and air around him would absorb his waste products in unlimited quantity. The ocean, the atmosphere, and even the solid earth were viewed as receptacles of essentially infinite capacity. We now recognize that on local, regional, and even worldwide scales we may have exceeded nature's capacity to dilute the effluence of our technology. The citizens of Los Angeles have long been aware of the effect of automobiles on the purity of air. But what is becoming clear to almost everyone is that what was once a local problem is now becoming a regional problem as the noxious products produced in the Los Angeles basin are spread over much of Southern California. Furthermore, the problem which was unique to Los Angeles in the 1940's is now common to the major cities in both the United States and abroad. What is perhaps not so widely recognized is that cities similar to Los Angeles may be changing the weather on a planetary scale. The effect of carbon dioxide and of particle pollutants on climate is not yet understood but there is increasing evidence that the observed worldwide decrease in temperature over the past two decades may in part be due to the small bits of matter spewed into the atmosphere by automobiles and industry, and which reflect a portion of the sun's warming rays back out into space.

4) The three categories of environmental change which I have discussed are well recognized as problems of utmost significance, However, there is another kind of environmental effect of man which may not be so widely appreciated and which could have disastrous consequences. Many of the forces which shape our planet are delicately balanced. The flow of heat from the deep interior of the earth out into space stretches and strains the earth's outer crust. These strains are balanced by the strength of the rocks which make up the crust. Occasionally, these forces come out of balance and an earthquake results. What man does may affect this delicate balance of forces. For example, in India a dam was built near the village of Koyna. As the dam was filling, an earthquake was triggered which killed 200 people in a neighboring village. This was an area in which no earthquake had been observed during previous decades. The added weight of the water on the crust changed the balance of forces that had existed at least for several decades. Dam building is not the only way you can stress the crust. Slow withdrawal of ground water throughout the entire Southwest has also changed the forces acting upon the crust; and we do not understand what effect this withdrawal of water will have on the balance of forces, particularly in the earthquake-prone region of Southern California. I have used the forces in the earth's crust and the possible triggering of a destructive earthquake as an example of nature's balance of forces. There are many others. Perhaps the most important of these are in the atmosphere. Man is also changing the nature of forces in the atmosphere through deforestation, urban construction, and the placing of oil on the ocean waters. We do not yet know the long-term consequences of these activities or whether these activities can indeed lead to disastrous and sudden release of the great energies stored within the atmosphere.

Measurement and Management of the Environment

In all of these various categories of environmental problems, I see that the key issue is how can we manage the environment in such a way as to preserve and enhance its values and, at the same time, meet the ends of a technologically based society which, at least for the coming decades, will be having an increasing population. This is an easy statement to make but a difficult one to implement. The difficulties arise in part because of the uncertainty in what is actually meant by the environment and what are its values. Indeed, one of the great needs for research is an attempt to understand the social psychology of the environment. How do people view the environment? How do the differences in personality, in social status, in cultures give rise to different sorts of responses to the same set of conditions? Among varying social groups how important is pollution as a high-priority problem? What do people expect of their future environment? And what causes changes in their expectations? Unfortunately, we do not have answers to such questions. And, therefore, management of the environment at this early stage will be at best a hazardous undertaking.

About the Author

DR. GORDON J. F. MacDONALD has risen to national prominence by his appointment to the President's Council on Environmental Quality. This council will head the President's anti-pollution drive. Dr. MacDonald brings to his new assignment an impressive list of credentials, including extensive work in the study of the upper atmosphere and weather modification.

Dr. MacDonald began his career with an exceptional record at Harvard. He received his A.B. summa cum laude, his A.M. and Ph.D. Degrees, and he served as a Junior Fellow from 1952 to 1954. After leaving Harvard, he taught at M.I.T. and did research at Carnegie Institute's Geophysical Laboratory. In 1958 he went to U.C.L.A. as a Professor of Geophysics, where he became Director of the Atmospheric Research Laboratory, Associate Director of the Institute of Geophysics and Planetary Physics, and Chairman of the new Department of Planetary and Space Science.

President Nixon's appointment is not the first of Dr. MacDonald's government work. He was a member of the President's Science Advisory Committee from 1965 to 1969.

Dr. MacDonald is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, an Associate of the Royal Astronomical Society, and thirteen professional and scientific societies. In addition, he is the author of over 100 articles on scientific subjects and is involved in editing seven scientific journals.

Dr. MacDonald is currently Vice-Chancellor for Research and Graduate Affairs at the University of California, Santa Barbara, where he came in 1968 after serving as Executive Vice President of the Institute for Defense Analyses.

We cannot effectively manage the environment without knowing what it is, what is was, and what it can be in a modern, expanding industrially-based society. There are those who would argue that the expansion must be halted and that, somehow, this by itself will solve environmental problems. I believe such a view to be unrealistic in that the forces shaping our society cannot be immediately deflected. While it may be possible and perhaps even desirable to reduce the rate of economic growth in the future, we certainly do not have enough knowledge to accomplish this today without potentially disastrous side effects. Thus, we must face up to the problem of attempting to manage the environment in an expanding society. The first step toward management is defining what we mean by the environment and measuring those parameters which affect it.

We cannot detect changes, desirable or undesirable, natural or manmade, without repeated observations and established baselines. These facts are obvious and yet we neither know, in a systematic way, just what the environment is nor do we know how it is changing or at what rate it is changing. We do make some baseline observations at present through such environmentally-oriented agencies as the Environmental Sciences Service Administration, U. S. Geological Survey, Bureau of Commercial Fishery, Bureau of Sports Fishery and Wildlife, Forest Service, National Air Pollution Control Adminstration and the Federal Water Pollution Control Administration. In addition, many local and State agencies secure data on environmental parameters. Most of these data are obtained for special purposes. Seldom is there a comparison of data; there are few comparative studies; and there is no overall evaluation of the quality of the environment. Thus, the National Air Pollution Control Administration monitors the chemistry of the air in urban centers emphasizing those compounds which may have some effect on human health. The Environmental Sciences Service Administration monitors, in a few isolated localities, the carbon dioxide content of the atmosphere. The data secured by both of these agencies are important to the understanding of the long-term changes in climate resulting from increased urbanization. Yet, the programs of these two agencies in monitoring are to a large extent independent.

At best it can be said that the existing environmental monitoring program has many critical gaps. In addition, some data-collecting programs, conceived of for some narrow, now half-forgotten function, yield information of minimal value for understanding the whole environment. Effective monitoring must be based on a carefully planned, totally integrated system of widespread repeated observations. At present, we do not have more than the base structure of such a program. The development of a national monitoring system must have the highest priority. It is clear that the monitoring should include at least the following:

1) The physical and chemical properties of land, air, and water;
2) The distribution of plants and animals in the land, air, and water;
3) Land use including diversity of purpose;
4) Construction;
5) Noise;
6) Epidemiology of man, animals, and plants.

It may also be important to attempt to measure how man is reacting to his environment. Evidence of environmental stress such as the consumption of tranquilizers or asocial behavior may provide such measures or we may have to develop entirely new measures. Then, there is that difficult and almost untouched question of how to determine esthetic qualities. Acres of billboards per mile of highway or miles of exposed telephone lines are possible candidates, although to some observers such features are considered to be esthetically pleasing.

This list is incomplete but it is far more diverse than the few components ordinarily monitored as parts of the environment. The necessity for very broad monitoring is suggested by the consideration of a relatively simple environmental relationship. Many people settled in Southern California to enjoy the sun and the broad, clean beaches. Houses were built right up to the edge of the beach which, in some places, became littered with kelp and buzzing with flies. The houses had displaced the tiny animals such as isopods which had previously eaten the kelp. More houses were built inland in areas subject to flood. Dams were built to protect the houses and the dams did stop the floods but they also stopped the flow of sand which replaced the beach sand which was being constantly lost to the ocean. The beaches became less wide and less widespread. Finally, to reach the more distant beaches, more and more people drove more and more automobiles and the resulting smog obscured the sun which had brought them to Southern California in the first place. This is a very simple outline of a most complex relationship. We cannot say what actually happened. Certainly, what happened was not the result of a systematic series of decisions. Rather, what happened was determined by a natural flow of events unfettered by planning. We will have no greater success in dealing with similar problems in the future without developing a comprehensive plan for monitoring the whole environment with its changes and for using that information in constructive planning.

Environmental Quality Indices

Measurement and monitoring of the environment should not, of course, be an end in itself but rather should provide an essential management tool. A good set of measurements can be most influential in the development of strategies and policies with regard to environmental matters. I believe that a key in dealing with long-term questions of quality of life lies in the establishment of national, regional, and local environmental quality indices. Such indices would provide some overall measure of the quality of the environment and, if maintained over time, could establish trends.

In some areas indices are already used and have been effective in keeping the public informed of problems. For example, the system of smog alerts in the Los Angeles basin and the numerical measure of the intensity of smog has contributed to public understanding of where the smog is worse and of how bad it really can be. There are few measures more likely to draw attention to the severity of the problem than the one which requires that children no longer participate in the usual playground activities because of the intensity of the smog.

In other areas of management, indices of various sorts play a critical role. For example, management of the economic affairs of the nation makes use of rates of employment and unemployment as well as measures and rates of growth of the gross national product. However, environmental affairs involve values that are either difficult or perhaps even impossible to evaluate in economic terms. Alternate means of defining these values are required. While it is not clear, in detail, how such over-all quality indices can be defined, I believe that a start should be made provided we recognize the difficulties and dangers in the adoption of such indices. If not based on sound research, on data collection and analysis, such indices would be of no positive benefit. They could, if properly utilized, be manipulated for economic and political advantage. However, their potential value as tools for management is so great that they should be developed and applied at various levels of government.

In addition to the development of indices for various parts of the environment I believe that it is necessary to have some over-all index of environmental quality. Such an index might be composed of some weighted measurement of the transparency of the air, the purity of the water, the ratio of the area of open ground to population, the noise level, the ratio of wild animals to human population, the ratio of the area of parks to the area of parking lots and the fraction of utility wires above ground. Anyone could make up such a list but I think that such an index, carefully developed, would be meaningless in drawing attention to the complexity of the problem of environmental quality as well as to the great variability in the environment throughout the nation. At some future time, we might even look forward to a federal or State administration which declares that its over-all goals are not to be measured solely in economic terms but also in terms of what the proposed programs do to the National Environmental Quality Index.

Monitoring the environment and the development of indicators of environmental quality will be helpful in learning about the environment and in alerting the public to changes in it. However, much more is needed. The understanding of the environment and of environmental changes must be translated into public policy, into public action.

Strategies for Environmental Management

In devising strategies it is essential to find out in advance where are the decision points—the times and places where decisions are made that profoundly affect the future. It is also necessary to recognize where are the levers —the instruments by which decision-makers can bring about significant changes. Clearly, one must also consider and periodically suggest changes in the institutions that are available in our pluralistic society for contributing to decisions on the environment: regulatory agencies, monitoring agencies, legislative committees, advisory groups to government at various levels, citizens organizations, study institutions, universities, and others.

The development of long-range plans and strategies will involve systems analysis of a special kind with very careful attention to variables which are difficult to quantify. It will be necessary to assess projects according to their effects on the total complex of systems and values, some of these effects possibly conflicting, and to include in the assessment public sensitivities to environmental quality.

It would seem to me that a fruitful theme in the development of tools for effective environmental management would be a shift in emphasis from exploitation and extraction, designed to promote growth for growth's own sake, to technical achievements that would benefit the environment such as:

1) Carrying out needed industrial tasks with less damage to the environment;
2) Repairing damage already done to the environment;
3) Providing attractive alternative employment to those engaged in activities that may have to be phased out to protect certain environmental values.

Strategies for effecting such changes in emphasis will undoubtedly include shifts in incentives, probably tax incentives at the federal, state and local levels.

A related question is that of importing into the market economy some of the external diseconomies of transportation, industry, and commerce, especially those involving the degradation of public goods like air, water, wilderness, wildlife, and the visual and auditory surroundings of man. A major question is to what extent should we supplement the present methods of dealing with matters at various levels of government by the setting of standards and prohibitions, with other methods such as user charges and tax incentives; and to what extent should we depend on the use of environmental quality indices in the competitive marketplace. These questions need to be addressed and if properly focused on, could extend in a meaningful way the science of economics to a far wider range of problems.

Just as classical economics has been stretched to accommodate the notion that air and water are not free goods in the usual sense and just as "cost of information" is being integrated into economic doctrine, so it may be desirable to incorporate more effectively into economic theory another important notion, that of diversity. For example, even though each of many small districts may maximize its economic benefit in a narrow sense by having the same mixture of cities, farms and wilderness, there is intuitively a great advantage in having urban concentrations of critical mass, large tracts of wilderness, and great rural expanse. The quality of the whole country would thereby be enhanced. On the practical side, the maintenance of diversity and the defense of esthetic values will require generalization in the concept of zoning in the direction of stronger and more lasting powers involving institutions other than those that are usually associated with the zoning authority. The existence of wilderness areas and parks are already examples affecting publicly owned land. But to establish rural belts, for example, would require new means of enforcing restrictions on the use of privately owned land. In developing long-range strategies, problems on a world scale are likely to play a significant role. The control of industry of its pollutants will in many cases result in a higher cost for manufactured products. Such restrictions and regulations may place American industry at a substantial competitive disadvantage with the rest of the world. What is needed is worldwide recognition of the character of the problems and an attempt to deal with them on an international scale.

Other problems affect all nations directly and must be dealt with on an international scale. For example, the world climate may be subject to cooling by aerosol pollution and to heating by carbon dioxide emission. With one sign or the other probably taking the lead, the danger of the melting of the icecaps or the dangers of a new ice age are not trivial. Another pressing problem is how are we to use the oceans. The use of the oceans, unless conservation and research take precedence over exploitation, could become another classical case of the tragedy of the commons—where the selfish interest of each single nation runs contrary to the common interest of all. The threat of the disappearance of the great whales is merely an early example of what may become a general misfortune.

The success of the efforts of the institutions designed to know and to manage the environment will depend on the existence of a strong constituency supporting such works. In the past this constituency has been developed to a large extent by the professional conservation groups within the country. In the future, a much broader base will be required. This can be achieved only through enhanced educational efforts. Of our higher education I can say only that the universities, so far, have shown little initiative and even less competency in introducing interdisciplinary programs designed to study the environment in a broad and deep way. However, in both primary and secondary education a few experimental programs have succeeded in introducing students at an early age to the basic principles of ecology and to the complex interdependencies which characterize the environment. These efforts will require much greater emphasis if we are to develop a constitutency which will not only support effective environmental management but is also knowledgeable about the problems of achieving such manegement.

The development of institutions and techniques to monitor and manage the environment will take many years. The time scale for the development of appropriate environmental quality indices and the introduction of these indices as management tools is a long-term proposition. Again, it will take years to construct the regulatory agencies, provide the legislation for tax incentives, develop new techniques for zoning and create the other instruments by which long-range planning and strategies can be brought into being. The very complexity of the environment, in which each part depends to such a great extent on every other part, makes the problems of environmental management extremely complex. There are no simple answers, and short-term expedients designed to bypass the complexities are likely to produce only more problems in the future. We need to face the complex issues now and to make a beginning in providing for the institutional base that will make possible the management of the environment.

Plant News

Bernie Nelson Appointed District Sales Manager, Melrose Div. of Clark Equipment

Berndean H. (Bernie) Nelson has been appointed a district sales manager for the Melroe Division of Clark Equipment Co., Gwinner, N.D. He will serve Melroe agricultural and industrial dealers in a territory comprised mainly of Montana and northern Wyoming.

Nelson has been in a Melroe sales training program for the past year. He and his family will reside in Great Falls. Prior to joining Melroe, Nelson was a logging contractor and was employed by Allis-Chalmers.

Melroe produces 4-wheel drive front-end loaders in 1,000- and 3,000-pound capacity sizes and a line of farm equipment. The agricultural products include a windrow pickup, reset plow, Harroweeder and Multiweeder.

Serpentix Conveyor Corp. Sets Up Sales Group

A sales organization covering nine eastern states has been established by Serpentix Conveyor Corp. of Denver, Colo., in an agreement with the Ensco-Vibro Companies headquartered in New Jersey.

Serpentix conveyor systems, which can be automated to any degree desired, are the only conveyors in existence capable of making 0° to 180° turns in a single plane, completing 360° turns in a spiral, and turning in a radius as small as 7 feet.

The appointment of Ensco-Vibro now gives Serpentix direct sales representatives and servicing capabilities in New York, New Jersey, Pennsylvania, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine.

Cardinal Petroleum Enters Nuclear Energy Field

Cardinal Petroleum Co., a Billings, Mont., based publicly held oil operating company, announced its entry into the nuclear energy field. Cardinal will attain a major position in the rapidly expanding nuclear fuel industry through the acquisition of Mountain West Mines, Inc., supplementing Cardinal's already active role in the oil industry as a drilling, pipeline, exploration and production company.

Mountain West Mines, Inc. is regarded as a pioneer in the development of the Powder River, Wyo., uranium district. Its holdings include mineral interests in several hundred thousand acres in Wyoming and Utah on which more than two million feet of exploratory drilling has been conducted during the past three years.

Lintner and Ahlborg Elected Directors of Colo. Mining Assn.

Robert E. Lintner, E.M. 1943, and William T. Ahlborg were elected May 15 to serve on the Colorado Mining Association's Board of Directors for the period ending February 1972. Mr. Lintner is manager of market expansion, Denver Equipment Division, Joy Manufacturing Co.; Mr. Ahlborg, vice president of Joy's Heavy Machinery Division. Both men are headquartered in Denver and have been long time members of the Colorado Mining Association.

Dr. Carson Research Geologist For Geodata Systems, Inc.

Dr. W. Pierce Carson has been appointed research geologist in the research and economic planning department of Geodata Systems, Inc.

Dr. Carson will conduct geoscientific studies of regions of the Western United States in which Geodata plans to conduct metallic mineral exploration. This work includes analysis of published geological data combined with field checking as a preliminary to the estimation of potential mineralization, and serves as a means of pointing out prime areas in regions for future intensive field exploration.

Geodata is an integrated mineral exploration firm, providing exploration program development and management, and airborne and surface exploration surveys including geochemical and geophysical surveys.

American Nuclear and Humble Oil Finalize Exploration Agreement

American Nuclear and Humble Oil Co. have finalized an exploration agreement on approximately 2,500 claims in the Red Desert Area of Wyoming. These claims are situated in an area Humble has been actively exploring.

Humble Oil assumes the cost of exploration for a possible four-year period. At that time, should they develop an economic ore body, they may purchase part or all of the claims involved and also further reserving to American Nuclear a yellow-cake royalty.

New Planetary Drive Axles For Big Front-End Loaders

Two new Rockwell-Standard heavy duty planetary axles, which provide for simplified servicing of brakes, have been introduced for the construction and mining equipment market by the Automotive Divisions of North American Rockwell Corp.

Designated the PR-800 and the PR-703, the new planetary drive axles are designed specifically for front-end loaders with a carrying capacity of six to eight cubic yards. Loaders of this size are used in operations such as heavy construction work and open-pit mining.

Kerr-McGee Supplies Uranium To Consumers Power Company

Kerr-McGee Corp., Oklahoma City, has contracted to provide enriched uranium hexafluoride valued at approximately $14.5 million to Consumers Power Co. of Jackson, Mich. The enriched uranium hexafluoride is scheduled for delivery in 1970.

Kerr-McGee will convert approximately one million pounds of its uranium concentrate (yellow cake) into natural uranium hexafluoride at its Sequoyah Facility in eastern Oklahoma.

The nuclear fuel will be used by Consumers in its Palisades nuclear power station, now in the final stages of construction in South Haven, Mich.

Sohio Buys N. M. Property In Uranium District

Reserve Oil & Minerals Corp. of Albuquerque has sold a one-half undivided interest in 120,000 acres of potential uranium properties in a three-county area to Sohio Petroleum Co. for $1,925,000.

The property is the L-Bar Ranch in the New Mexico counties of McKinley, Sandoval and Valencia, about 40 to 50 miles northwest of Albuquerque. The ranch is in the Laguna uranium mining district, and about 25 miles east of the Ambrosia Lake district. A uranium deposit, the L-Bar ore body, has been known on the ranch for several years, but it has not been developed or its extent fully determined.

FluoSolids Roasting System Being Installed in the Congo

A contract for a FluoSolids Roasting System to treat 350 MTPD copper-cobalt concentrates at the Luilu plant of Société Gecomin, in the Congo's Katanga Province, was awarded to Dorr-Oliver S.A. in Brussels.

The well over a million-dollar contract was awarded on a turn-key basis and will use the combined design and engineering technology and facilities of the parent company and of Dorr-Oliver S.A. and Dorr-Oliver S.p.A. in Milan, Italy.

The new installation is expected to go on stream in January 1972. It will be the 12th full-scale Dorr-Oliver FluoSolids roasting system to go into operation on copper concentrates in the rich African copper belt that extends from Zambia into the Congo.

Catalogs and Trade Publications

SPEED REDUCER CATALOG (617)
Hewitt-Robins Power Transmission Equipment Division of Litton Industries, Stamford, Conn. 06906, has published a new 16-page catalog covering its line of Maxi-Power, parallel shaft, single reduction speed reducers. The new publication provides complete performance tables for the 14 different sizes in the line for input speed ratings of 1750, 1170, 870, 720 and 580 r.p.m. In addition, the catalog gives application data, selection procedures, complete dimensions keyed to three-view drawings on all sizes, a bedplate selection chart and general dimension charts on heat exchangers, fan-cooled units and backstop clearances. **Circle 617 on Reader Service Card.**

NEW VARIDRAULIC BROCHURE (618)
A new technical catalog covering its complete line of VariDraulic® couplings and drives is available from the Dynamatic Division of Eaton Yale & Towne Inc., Kenosha, Wis. 53140. The fully illustrated catalog contains complete product and operational descriptions, ordering instructions and horizontal and vertical dimensional data. The 12-page catalog also contains coupling and shifter level dimensions, selection charts and photos of typical applications. The colorful book also includes torque slip curves and a glossary of terms common to the VariDraulic line. **Circle 618 on Reader Service Card.**

7,000 PLASTIC PRODUCTS (619)
A free 112-page catalog describes, illustrates, and prices over 7,000 items including tanks and tank fittings, pipe and pipe fittings, tote pans and labware, tubing and tube fittings, bolts, nuts and washers, electric and hand pumps, pails and scoops, filters and mixers, valves and spigots, welders and sealers, sheet and rod, aprons and gloves, bottles and carboys, and many more items. (U. S. Plastics, 1550 Elida Road, Lima, Ohio 45805.) **Circle 619 on Reader Service Card.**

HYDRAULIC CRANE (623)
A new 30-ton, carrier-mounted hydraulic crane is the subject of a new color bulletin and specification sheet, offered by the Austin-Western Division of Baldwin-Lima-Hamilton Corp., Aurora, Ill. 60507. A fully-automatic, self-proportioning power boom is discussed as the key element in permitting superior performance at longer reaches.
Diagrams and charts show principal dimensions, including safe load capacities with each boom option at different working radii and boom angles from zero to 75 degrees. A brief summary of 630-CM features includes 360-degree continuous glide boom rotation with fail-safe brake; single line pull to 10,300 pounds; hoist speeds to 310 fpm, power up and power down, free fall line optional; twin boom-lift cylinders (zero to 75 degrees), and 8 x 4 carrier. A deluxe operator's cab with air-conditioning available optionally, and outriggers, controllable from the crane cab, are among other features noted. Outriggers afford 18-inch vertical stroke and 16-foot horizontal spread. Send for a copy of Bulletin AD-2840 with Specification Sheet 2836-R1. Circle **623 on Reader Service Card.**

PROCESS INSTRUMENTATION (624)
A 24-page booklet recently prepared by The Foxboro Co., Foxboro, Mass. 02035, describes a variety of publications available on the subject of process instrumentation. The booklet, Foxboro Publication No. 197, lists textbooks written by Foxboro experts, as well as handbooks, article reprints, and product and application bulletins. A description or summary accompanies each listing. **Circle 624 on Reader Service Card.**

CONDENSER VACUUM PUMPS (625)
Design, operating and construction features of two-stage, water-cooled Ro-Flo rotary vacuum pumps for condenser air removal service are described in new Allis-Chalmers literature (Form 16B3812). Seven standard sizes of the positive displacement, sliding vane units are available in ratings from 4.0 to 21.5 cfm free dry air at 71.5 F and one in. Hg abs. They are designed to operate at standard electric motor speeds using low starting torque motors. **Circle 625 on Reader Service Card.**

RATCHET PULLER (620)
Beebe Bros., 2724 6th Ave. So., Seattle, Wash. 98134, has a new four-page brochure covering their complete line of ratchet puller winch hoists. Six models are available with capacities to 4,000 lbs. Light weight, the heaviest unit is only 9 lbs. Ask for Form RP-4. **Circle 620 on Reader Service Card.**

OSCILLOSCOPE (621)
A new sonar-type instrument that measures the level of bulk materials and presents a graphic oscilloscope picture of the material surface is described in new literature available from C. W. Stevens, Inc. Designated as Bulletin 3001, the two-page piece outlines the principle of SONARGAGE systems as well as the advantages of the oscilloscope presentation. **Circle 621 on Reader Service Card.**

Send Us Your Bulletins

Send your publications to The MINES Magazine, 2177 W. 7th Ave., Denver, Colo. 80204, for review in these columns.
To all MINES readers these publications are FREE, and may be ordered by giving index number.
On requesting publications from manufacturers, please mention the MINES Magazine.

G-S LABOCOPEIA (622)
Gallard-Schlesinger Chemical Mfg. Corp., 584 Mineola Ave., Carle Place, L.I., N. Y., 11514, is pleased to announce the publication of the first issue of the "G-S LABOCOPEIA." This publication describes a number of research and laboratory chemica's as well as laboratory equipment of general interest in the following areas: Analytical Chemistry, Biochemistry, Organic Syntheses, Chromatography, Physical Chemistry, Water Pollution Control. **Circle 622 on Reader Service Card.**

BULK HANDLING SYSTEMS (623)
Hewitt-Robins Bulk Handling Equipment Division of Litton Industries (Stamford, Conn. 06906) has produced a comprehensive 36-page catalog describing the systems materials handling approach of its Robins Engineers and Constructors operation. Catalog RE&C 10-C includes more than 75 photos and drawings of a wide variety of materials handling systems designed and erected by the operation throughout the world. It outlines the operation's experience, technical abilities range of services and total capabilities in systems, including overland conveyor complexes, blending plants, marine terminals, self-unloading ships and barges, stripmine and earthwork dam facilities, cement and aggregate plants and electric power plants. **Circle 623 on Reader Service Card.**

200 SERIES SCRAPERS (624)
Titled 200 Series Scrapers, this new catalog (D-b-TP634) issued by WABCO Construction Equipment Division, (Peoria, Ill. 61601), presents complete information on the 229F conventional scraper (21 cu. yds. heaped) and on the 222F elevating scraper (22 cu. yds. heaped). Its 24 pages picture and describe extra comfort and safety features for easy operation for high-speed, profitable performance; show how fast cycles result from the efficient and matched power-transmission package; how the dependable final drive delivers full power to the drive wheels; and how the proven hydraulic system achieves smooth, effortless steering action and better scraper performance. Also shown is how WABCO 200 series scrapers produce longer without downtime and cost less to maintain. Circle **624 on Reader Service Card.**

ELECTRO BALANCES (625)
A comprehensive new all-product catalog (No. 135) has been published by Cahn Division/Ventron Instruments Corp., Paramount, Calif. 90723. The 16-page catalog covers the company's electrobalances for scientific and engineering laboratory applications, including Millibalances, Microbalances, Recording Balances and accessories and fully Automatic Recording Balances. A section on applications discusses major uses of Microbalances in Thermogravimetric Analysis, Surface Area Measurements, Magnetic Susceptibility, Particle Size Determination, Surface Tension, Density and others. Charts are provided for selection of stirrups, sample containers, weights and other balance accessories. **Circle 625 on Reader Service Card.**

POLLUTION CORRECTION (626)
Eight-page brochure by Rolfite Co., Stamford, Conn. 06901, describes Rolfite patented liquid nitrogen and manganese complex which modifies fuel oils. Lists contaminants which are substantially reduced or eliminated, such as sulphur oxides, smoke, noxious gases, vanadium and acid smut; also details economies in combustion efficiency and maintenance which more than cover cost. Requires no agitation or proportioning equipment as chemical is oil soluble and distributes itself uniformly when dropped into tank at time of oil delivery. **Circle 626 on Reader Service Card.**

CABLE TRAY SYSTEMS (627)
A new manual containing basic information on cable tray systems has been released by the Metal Products Division of United States Gypsum Co., 101 S. Wacker Dr., Chicago, Illinois, 60606. A 20-page booklet, it gives specifications and application details on channels, connectors, supports and accessories for CABLE STRUT Cable Tray designed to carry electrical cables from their origin to their point of termination. Amply diagrammed and illustrated throughout, the manual is entitled, "An Introduction to Cable Tray." **Circle 627 on Reader Service Card.**

COMPLETE PLASTIC BAGGING (628)
A new versatile hand tool that produces an unlimited variety of plastic bags providing instant response to changing packaging requirements is announced by Harwil Co., Santa Monica, Calif. 90404. Key to versatility of the T-1000 is the use of lay-flat plastic tubing in a multiple-roll, quick-change mix of any width from 1 to 12 inches. The tool consists of only four elements: 1) plastic tube support, 2) double action cutter, 3) heat sealer, and 4) a sturdy press board base. Unit construction provides ready-to-operate portability for added flexibility to meet all bagging problems whenever and wherever they occur. **Circle 628 on Reader Service Card.**

ENVIRONMENT AND GROWTH (629)
The growth of AMAX (American Metal Climax, Inc.) as a major natural resources development company during the Decade of the Sixties is highlighted in the Company's 1969 annual Report. The report departs from the usual mining company format to feature successful AMAX efforts in dealing with environmental problems in its varied operations. The front and back covers of the report depict environmental control projects at the Company's molybdenum mining sites in Colorado and coal mining operations in the Midwest. These show children fishing, cattle grazing, young people water-skiing and corn growing on land once devoted to mining operations. **Circle 629 on Reader Service Card.**

AUTOMATIC THROTTLING (630)
Now available from the Clarkson Co., Palo Alto, Calif. 94303, is a new actuator for automatic throttling control with the Clarkson Series B Slurry Valve. This new control is called the Clarkson Positioning RD (for rolling diaphragm) Actuator. It extends the B Valve into throttling control utilizing 3 to 15 psi air signals. Typical applications: as the final control element in all slurry processing—density, flow, level, etc. The new Positioning Actuator is fully described in Bulletin 20-10. **Circle 630 on Reader Service Card.**

BIN LEVEL INDICATION (633)
Continuous metering and control for bulk handling of granular and liquid materials in all size bins, tanks and silos is offered by Genco's "Levelguard" systems. Adaptable to either storage or processing operations, Levelguard systems are available for continuous indication, giving precise level readouts in any size and shape of vessels. Systems can be equipped with dial meters, bar-graph distance reading columns, automatic controls or alarm horns, bells or lights. A non-radar system, Levelguard has no moving parts and provides maintenance-free operation and accurate measurement at all times, according to Mechtron-Genco Corp., Alliance, Ohio 44601. Free literature (Bulletin GCO-170-70) supplies complete details. **Circle 633 on Reader Service Card.**

WANT MORE INFORMATION?

Use MINES Magazine's convenient READER SERVICE CARD, circling numbers that correspond to items interested in, then drop card in mail. No stamp needed!

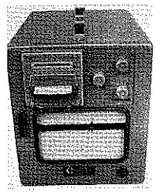
With the Manufacturers

Radiation Detection (537)

The detection head of General Electric's NucleEye Monitor has an active diameter of three millimeters. This provides a capability to probe for radiation, thus enabling hand held scanning with better spatial discrimination than with larger probes currently available. Here, the NucleEye Monitor is used to scan a leaf for possible radiation, and inpoint that radiation. **Circle 537 on Reader Service Card.**

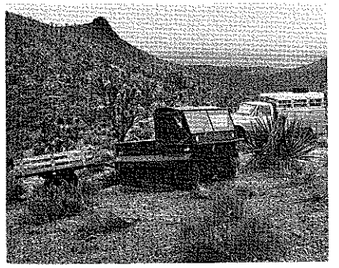
Husky Mining Diesel (533)

A new four-wheel drive diesel-powered front-end loader developed by Erickson Corp., 211 St. Anthony Blvd., N.E., Minneapolis, Minn. 55418, has just been approved for underground use by the U. S. Bureau of Mines. Designated the LC4D-MD Husky Mining Diesel, the loader is specially designed for mucking, loading and unloading, digging and filling, leveling and cleaning up haulage ways. It can be supplied with either a 7.5 or 10-cubic-foot bucket. **Circle 361 on Reader Service card.**



Atmospheric Analyzer (541)

A highly accurate atmospheric sulphur dioxide analyzer has proven itself in rigorous field tests and is now available for studies of air pollution from Calibrated Instruments, Inc., New York, N. Y. 10023. Featuring the ability to operate unattended for more than a week, it will telemeter the average SO_2 every 15, 30 or 60 minutes. Simultaneously it will print a tape with month, date, hour and minute of the average it is recording. The continuous chart recording is instantaneous enough to detect a plume of SO_2 of the shortest duration. The ULTRAGAS SO_2 Analyzer is nonsensitive to CO_2, has a built-in self-zero and is automatic. **Circle 541 on Reader Service Card.**



All-Terrain Vehicle (536)

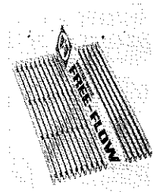
High mobility for induced polarization and resistivity geophysical surveys is gained by pairing an LTV-KID all-terrain vehicle, which has four wheels on each side, with a GMC 4-wheel drive transmitter truck. Geodata Systems, Inc., has devised the system to conduct mineral exploration in rugged desert regions, which often are located away from roads and trails. **Circle 536 on Reader Service Card.**

Fluxgate Magnetometer (535)

A new lightweight and portable Fluxgate Magnetometer is available from Geophysical Instrument and Supply Co. The battery powered unit is designed for field or laboratory use in stratigraphic correlation and age determination using the magnetic polarity method. The new instrument has solid state circuitry, weighs less than two pounds, and has a sensitivity of 25 to 2.50 gammas. **Circle 535 on Reader Service Card.**

Pulverizer-Classifier (540)

The Bauer Hurricane Pulverizer-Classifier (Springfield, Ohio), an air attrition mill with integral clarifier, used in processing operations where precisely controlled pulverization, classification and positive extraction of impurities are required, is now available with a high density Coors alumina ceramic lining. The new ceramic lining far outlasts high alloy metals and provides positive protection against iron contamination and discoloration during the grinding-classification operation. It is recommended especially for the processing of calcined clay, calcined gypsum, diatomaceous earth and other abrasive minerals and chemicals. **Circle 540 on Reader Service Card.**

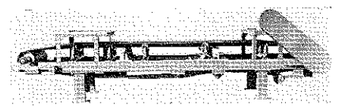


"Free-Flow Screen (538)

Wedge-Wire Corp. of Wellington, Ohio 44090, has introduced its new "Free-Flow" screen to provide faster screening action than conventional loop-type screens. The new screen is made with a ribbon lock-bar process. Precision machined cross-bars are inserted in slotted longitudinal profile bars, locked into place, then automatically welded on the underside only. The manufacturing method is said to result in a new high degree of opening accuracy for close tolerance screening. **Circle 538 on Reader Service Card.**

Remote Oculometer (534)

A scientist at Honeywell's Radiation Center has invented an eye-movement-tracing device that may revolutionize American technology more than anything since the computer. Prof. Marvin Minsky of nearby Massachusetts Institute of Technology says the remote oculometer invented by John Merchant may be a step in the direction of giving machines "eyes" to aid computer "brains" in making decisions and solving problems. Applications are already seen for industry, education, military reconnaissance and space travel. **Circle 362 on Reader Service card.**



Weighing Feeders (539)

Ramsey Engineering Co., St. Paul, Minn. 55113 has introduced a new family of Integral Weighing Feeders for bulk material handling processes. Available in constant speed or variable speed models, they provide reliable feeding, accurate weighing, totalizing and controlling of flow of a wide variety of materials; load-out or batching control for predetermined quantities; or ratio or proportioning control for two or more materials combined in a predetermined but adjustable ratio. **Circle 539 on Reader Service Card.**

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Campus Headlines

$20,000 NASA Contract For Theoretical Study

The CSM Chemical and Petroleum Refining Engineering Department has received a $20,247 contract from the National Aeronautics and Space Administration. This project is to support the works of Professors J. O. Golden and F. J. Stermole in "Phase-Change Thermal-Control Technology" for a one year period starting Jan. 1, 1970.

For many years phase-change has been important to chemical and petroleum refining engineers in relation to petroleum refining operations such as crude oil transportation, cracking and dewaxing, asphalt formation, crystallization processes and shale oil recovery from oil shale.

This research is concerned with the experimental and theoretical study of phase-change phenomena concluding with the design of more efficient phase-change thermal-control devices.

Phase-change may be utilized for the thermal-control of spacecraft instrument packages by surrounding these instruments with an envelope of paraffin type material of a relatively high fusion heat. Excess heat from the instrument package causes the phase-change material to melt, or cooler temperatures will cause the liquid material to solidify, while constant temperatures are maintained around the instruments until most of the phase-change material melts or solidifies.

Proper design of phase-change thermal-control devices for optimum energy transfer requires a thorough understanding of the basic mass and energy transfer phenomena involved.

Visiting Professor Of Mineral Economics

DR. HUBERT E. RISSER has joined the faculty of the Colorado School of Mines as a visiting professor of Mineral Economics. Dr. Risser is occupying the Coulter Chair. This Chair is a gift given in memory of the late William J. Coulter.

Dr. Risser received his Engineer of Mines Degree from the Colorado School of Mines, his Master of Science Degree in Mining and his Ph.D. in Economics from the University of Kansas.

He is a member of numerous scientific and professional societies and is the author of more than 30 publications and articles dealing with the economic aspects of minerals and the role of minerals in the modern industrial economy.

Dr. Risser and his wife live at 21 Mines Park in Golden.

John Reid, left, chairman of the Mines student committee hosting Tulsa high school students and counselors for Engineers' Day, pins "Tulsa Visitor" ribbon on Harry A. Ells, Jr. '54, who served as "wagonmaster" for the Oklahoma visitors on their trip. Left to right from Ells are Tulsa students Win Burrington, Dave Nichols, Bruce Portz, and Mike Moore. Eight students and four counselors made the trip to E-Day sponsored by the Tulsa alumni of the Colorado School of Mines.

Tulsa Students Visit Mines

A GROUP of Tulsa, Oklahoma, high school students and counselors visited the Colorado School of Mines to participate in the 36th annual Engineers' Day program, Friday and Saturday, April 17-18.

Tulsa alumni of the school sponsored the trip for eight students and four counselors. Norman S. Morrisey '42, vice president of Geo-Data Corp., led the fund-raising drive to make the trip possible.

The group made the trip in a sleeper bus, leaving Tulsa on Thursday evening and arriving in Golden at 7 a.m. Friday.

After meeting their host Mines students and having breakfast at the Kappa Sigma fraternity house, they attended the full schedule of Friday's E-Day activities.

Friday evening the counselors were hosted by Mines officials at a dinner at Mt. Vernon Country Club on Lookout Mountain.

Saturday, the group took the bus for a visit to CSM's Experimental Mine for a tour of the underground facilities and demonstrations of equipment. After the mine tour, they went to the Loveland Basin Ski Area to view mountains and scenery and become acquainted with "Ski Country U.S.A."

Saturday afternoon the students and counselors toured the campus, visited the academic departments, watched E-Day contests, and had supper at the College Union before leaving for Tulsa at 8 p.m.

While on campus, the students had rooms and ate most of their meals at the various fraternity houses. The counselors stayed at the Holland House.

High school students and counselors from throughout Colorado attend Engineers' Day, but Tulsa is the only out-of-state group that makes an all-out effort to participate in the Mines event. This is the second year for such a trip.

Students making the alumni-sponsored journey were prospective Mines students who are interested in the courses of study offered by the mineral engineering university.

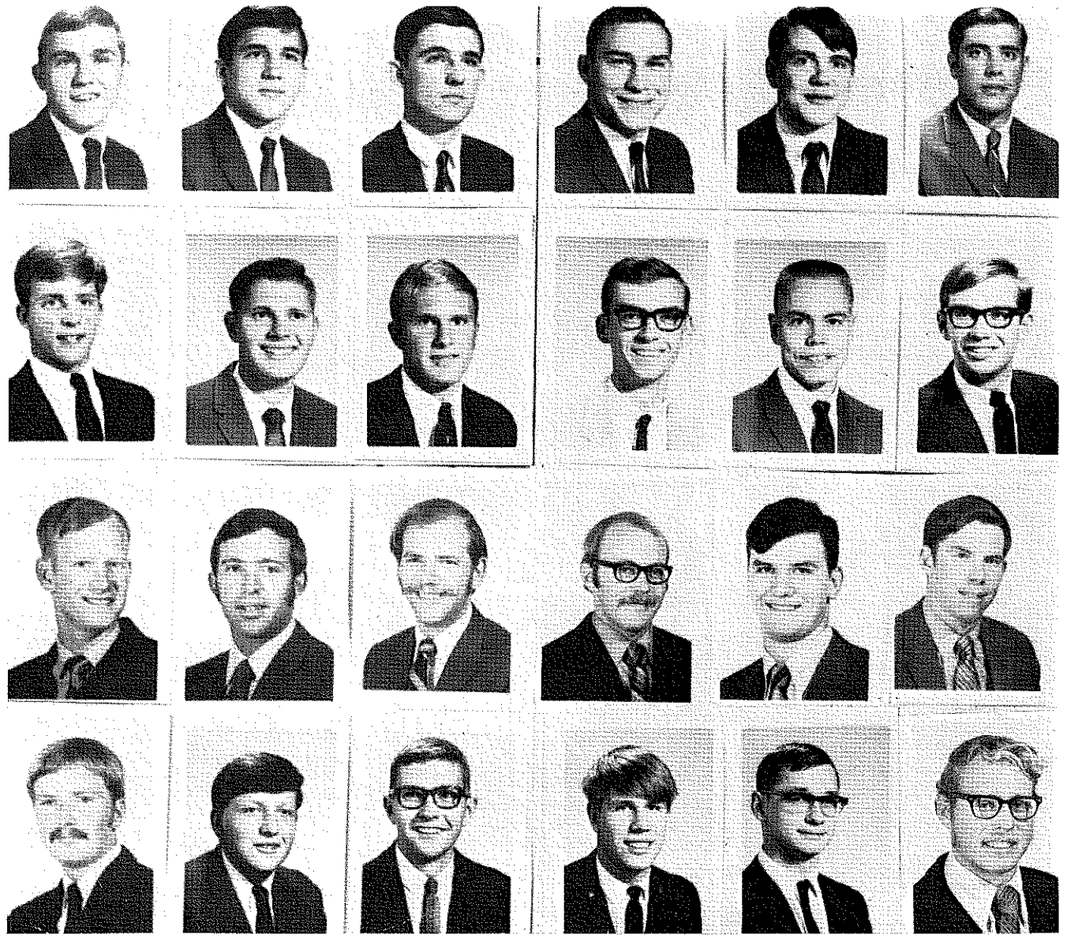
The students were Win Burrington, Dale Nichols, Bruce Portz, Mike Moore, David Brandenburgh, Clifford Hale, Craig Gaines, and Stan Bunnell. Counselors were Mrs. Allyne Verkins, Mrs. Bernice Smith, Robert J. Nelson, and Harley King.

Heading up the trip and representing the Tulsa alumni was Harry A. Ells, Jr., a 1954 graduate of Mines.

Edward T. C. Chao CSM Speaker

Dr. Edward T. C. Chao, of the United States Geological Survey, Washington, D. C. Office, spoke on "Shock Metamorphism Mineralogy" May 20 at mines.

Dr. Chao, a pioneer in the research field of shock metamorphism, spoke on application of this field in areas such as the origin of ore bodies and the impact of meteorites.



TWENTY-FOUR FROM MINES IN 1970 WHO'S WHO AMONG STUDENTS—**Top Row,** left to right: Robert Scharp, David Duston, David Armstrong, Stephen Onorofski, Lloyd Winger, Charles Slizewski. **Second Row from Top,** left to right: John Reid, Greg Siebers, William Pearson, Dale Bingham, Barry Sauve, Robert Deister. **Third Row from Top,** left to right: Lee Turner, William Server, Stephen Pavel, Charles Bloomquist, Craig Garrett, William Smith. **Bottom Row,** left to right: Michael West, Timothy Haddon, Carl Winters, Gary Andes, Donald Rakowski, Mike Krein.

24 C.S.M. Students In "Who's Who"

Twenty-four students at Colorado School of Mines are named in this year's national listing of America's most outstanding university and college students.

Who's Who Among Students is a listing of the campus leaders from more than 1,000 of the nation's institutions of higher learning.

The annual director of distinguished students has been published since 1934 and carries only the names of students whose academic standing, service to the community, leadership in extracurricular activities and future potential are decidedly above average.

Who's Who students honored at Mines are: Gary L. Andes, Brooklyn, Iowa; David W. Armstrong, Westminster, Colo.; Charles W. Bloomquist, Littleton, Colo.; Dale E. Bingham, Lakewood, Colo.; Robert E. Deister, Grand Junction, Colo.; David D. Duston, Golden, Colo.; Craig Garrett, Haxtun, Colo.; Timothy J. Haddon, London, England; Michael Krein, Johannesburg, South Africa; Stephen A. Onorofskie, Englewood, Colo.; Stephen K. Pavel, Prairie Village, Kan.; William C. Pearson, Pueblo, Colo.; Donald W. D. Rakowski, St. Albans, Vt.; John E. Reid, Englewood, Colo.; Barry L. Sauve, Golden, Colo.; Robert C. Scharp, Lakewood, Colo.; William L. Server, Newport Beach, Calif.; Gregory R. Sievers, Colo. Springs, Colo.; William H. Smith, Hotchkiss, Colo.; Charles J. Slizewski, Denver, Colo.; Lee Turner, Englewood, Colo.; Michael W. West, Colo. Springs, Colo.; Lloyd Winger, III, Arvada, Colo.; Carl W. Winters, Durango, Colo.

Dow Chemical Scholarship

During Engineers' Day (Apr. 17-18) at the Colorado School of Mines, the Dow Chemical Co. presented a $500 check to CSM for scholarship aid in the Metallurgy Department. This is the latest gift in a continuing program by Dow Chemical in providing much-needed support in funds and equipment for the School of Mines.

NAEB Conference

Gurnett Steinhauer, vice president for Business Affairs for Colorado School of Mines, gave the welcoming address to the National Association of Educational Buyers Conference held at the Grand Ballroom of the Denver Hilton Hotel May 14. This national association is comprised of buyers and business managers of our nation's colleges and universities.

ROTC Cadets Recognized

During the annual inspection of the Reserve Officers' Training Corps (ROTC), 27 cadets were recognized by special awards at the 1969-1970 awards ceremony at Colorado School of Mines in Golden.

Following the inspection of the cadets in formation by Colonel Thomas Cooper, professor of Military Science at the University of Colorado, on May 11, the following cadets received the listed awards.

Lee A. Turner, Englewood, Colorado—U.S. Army Superior Cadet Medal for outstanding military and academic senior class student.

Lyle V. Bonham, Colorado Springs, Colorado—U.S. Army Superior Cadet Medal for outstanding military and academic junior class student.

Roger L. Olsen, Yuma, Colorado—U.S. Army Superior Cadet Medal for outstanding military and academic sophomore class student.

Stephen M. McKenna, Craig, Colorado—U.S. Army Superior Cadet Medal for outstanding military and academic freshman class student.

Bruce E. Taylor, Aneheim, California—The Society of American Military Engineers Gold Medal as outstanding senior cadet who has demonstrated the highest standards of military leadership.

William C. Duesbury, Denver, Colorado—The Society of American Military Engineers Gold Medal as outstanding junior cadet who has demonstrated the highest standards of military leadership.

Dale E. Bingham, Lakewood, Colorado—The Denver Post Outstanding Cadet Medal for the senior class.

Leonard D. Jones, Cheyenne, Wyoming—The Denver Post Outstanding Cadet Medal for the junior class.

David Lombard, Golden, Colorado—The Denver Post Outstanding Cadet Medal for the sophomore class.

Gary W. Hudiburgh, Potomac, Maryland—The Denver Post Outstanding Cadet Medal for the Freshman Class.

Howard C. Parker, Davenport, Iowa—The Reserve Officers Association Medal for outstanding military and scholastic achievement during his four years at CSM.

Robert L. Hunt, Colorado Springs, Colorado—The Reserve Officers Association Plaque as the underclassman contributing the most to the corps of cadets through his exemplary citizenship.

Robert D. Wunder, Golden, Colorado—The Association of the U.S. Army ROTC Medal for contributing the most through his leadership as a junior class student.

George V. Rux, Aurora, Colorado—The American Legion Gold Medal to the senior displaying qualities of military leadership, discipline, character, and citizenship.

Robert E. Losey, Arvada, Colorado—The American Legion Silver Medal to the junior displaying qualities of military leadership, discipline, character, and citizenship.

Gary L. Andes, Brooklyn, Iowa—The American Legion Gold Medal for Scholarship Excellence for outstanding scholastic achievement, leadership quality, and participation in student activities.

Stephen P. Westhoff, Ft. Morgan, Colorado—The American Legion Silver Medal for Scholarship Excellence for outstanding scholastic achievement, leadership quality, and participation in student activities.

James H. Hubbugh, Denver, Colorado—The Sons of American Revolution Bronze Medal as the senior cadet displaying exceptional leadership, soldierly bearing, and excellence.

Rodney J. Eichler, Arvada, Colorado—The Veterans of Foreign Wars Medal and Plaque as an outstanding junior cadet for excellence in military leadership and personal character.

Charles B. Hirshman, Casper, Wyoming—The Daughters of the American Revolution Gold Medal for displaying outstanding abilities and achievements in the ROTC program.

Terry H. Krupp, Ft. Detrick, Maryland—The Scabbard and Blade Gold Medal for Military Excellence as outstanding senior cadet who has demonstrated excellence in military science and contributed the most to the corps of cadets.

Jon Ford, Riverton, Wyoming—The Scabbard and Blade Gold Medal for Military Excellence as outstanding junior cadet who has demonstrated excellence in military science and contributed the most to the corps of cadets.

John M. Neubauer, Sterling, Colorado—The Scabbard and Blade Silver Medal for Military Excellence as an outstanding sophomore cadet who has demonstrated excellence in military science and contributed the most to the corps of cadets.

Randall K. Ashliman, Craig, Colorado—The Scabbard and Blade Silver Medal for Military Excellence as an outstanding freshman cadet who has demonstrated excellence in military science and contributed the most to the corps of cadets.

Michael T. Hagan, Denver, Colorado—The National Society of Daughters of Founders and Pioneers of America ROTC as an outstanding senior who has demonstrated excellence in military science.

Stephen P. Choquette, Denver, Colorado—The National Society of Daughters of Founders and Pioneers of America ROTC Medal as an outstanding junior cadet who has demonstrated excellence in military science.

Robert D. Wunder, Golden, Colorado—The Colorado School of Mines Club Trophy who has contributed most to the rifle team.

Peters

Organization Appointment

Dr. Philip F. Dickson, Chemical and Petroleum Refining professor at Mines, has been appointed by the U. S. Department of Interior to the Emergency Petroleum and Gas Administration for a three-year term.

This organization is the Interior's petroleum and gas unit for the National Defense Executive Reserve.

ROTC Professor

Captain Donald G. Peters has been appointed Assistant Professor of Military Science and Property Officer in the ROTC Department at Colorado School of Mines.

Captain Peters attended the University of Missouri at Rolla. His hometown is Humphreys, Mo., where his parents, Mr. and Ms. William D. Peters, reside.

$700,000 Grant from NSF

ANNOUNCEMENT was received Friday, May 1, that Colorado School of Mines has been awarded a $700,000 grant from the National Science Foundation, Science Development Program. This grant will be directly applied by CSM to the area of science related to Geoscience-Mineral Resources.

Direct application of the three-year grant will be through the Geology, Geophysics, and Chemistry Departments at Mines. The funding will directly apply to the addition of new faculty staff members, supporting personnel, the purchase of research equipment, development and expansion of interdisciplinary fields in the areas of geochemistry, mineral economics, hydrology and pollution control, with additional expansion of CSM's over-all graduate student facilities.

A departmental science development proposal was originally written by Dr. Raymon E. Bisque and submitted in the fall of 1968 by Dr. Bisque and Dr. Orlo E. Childs to the National Science Foundation. Within this proposal it pointed out the needs for maintaining the quality of our natural environment by the development of advanced studies and research at CSM to keep pace with modern technology and science as it relates to mineral resources and man's role in shaping his environment.

Following this ideal, the objectives were stated with a plan to establish the best possible academic and physical environment for the training of highly qualified engineers and scientists thus alleviating the critical national shortage of skilled manpower in every phase of mineral exploration, extraction, processing and utilization.

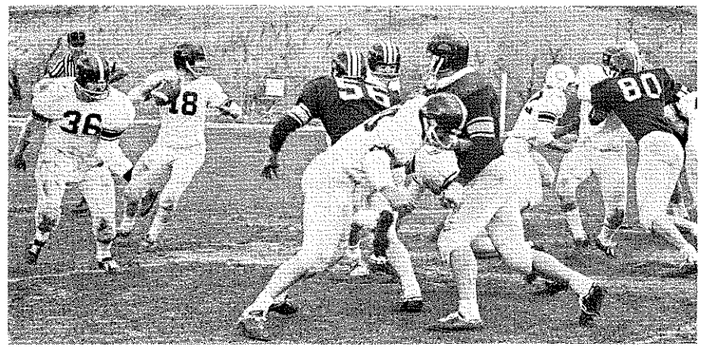
In addition the program will be developed with full awareness of those aspects of mineral economics, conservation, waste utilization, and pollution that are necessary to maintain the quality of our natural environment consistent with wise and effective use of our resources.

Major decisions in the geoscience and mineral resource fields will be accomplished through the common interests shared by the Geology, Geophysics, and Chemistry departments on campus. The grant will bring about the development of common laboratories and research facilities therefore encouraging the interdisciplinary efforts by the departments.

The entire Geophysics Department and the majority of new research space for the interdisciplinary programs relating Geology and Chemistry will be housed in the new Cecil H. and Ida Green Graduate-Professional Center, which is currently under construction on the CSM campus, This center will also house a computer center facility of the third generation type and an instrumentation complex for analysis of earth materials.

Colorado School of Mines expects to maintain the achieved levels of improvement after this National Science Foundation, three-year grant ends, by continuation of an aggressive promotional program both from the state funds and non-state sources including industry and government. The new Cecil H. and Ida Green Graduate-Professional Center, a three-million dollar complex, has been funded primarily by private and industrial contributions. The funding for this graduate-professional center is an example of the type of support that can be achieved through an over-all aggressive program.

Oredigger Sports



TOM GARNER, quarterback for the alumni tried in vain to place the alumni on the scoreboard during the second half of the 10th Annual Varsity-Alumni Football Game. Garner completed 14 of his 28 passes for 100 yards, and had one interception which netted the varsity a TD. Garner finally gained the alumni's only TD during the 3rd quarter with a one-yard line plunge.

Outstanding American College Athletes

Colorado School of Mines announced recently that **Nelson King** and **Richard Kehmeier** will be honored in the 1970 volume of Outstanding College Athletes of America. Nominated by their schools earlier this year, these athletes were chosen to appear in this awards publication on the basis of their achievements.

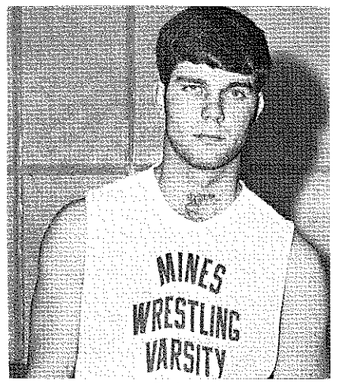
Nelson King is a junior, majoring in Metallurgy. He was named to the 1969 RMAC All-Conference teams in baseball and football. Nelson has received five varsity letters at CSM and was named the Outstanding Junior Athlete of the current calendar year.

Richard Kehmeier is a senior Geology major. He participates in track and has earned four varsity letters in this sport. He holds the fieldhouse, indoor and outdoor CSM records in the 440 yd. event, the outdoor CSM records in the 220 yd. event and is a member of the indoor record holding mile relay team for CSM.

Outstanding College Athlete of America is an annual awards volume featuring the biographicals and accomplishments of approximately 5,000 young athletes who have proven themselves outstanding in sports, campus activities and curriculum.

Nominations for this awards volume are made by athletic departments of colleges and universities throughout the country. Criteria for selection include an athlete's sports achievements, leadership ability, athletic recognition and community service.

An auction sale is where you get something for nodding.



Bush

Victor Bush Appointed To NAIA District Team

For the first time in the history of the NAIA District 7 area, an all-district team has been voted on by the participating schools. Adams State College of Alamosa placed eight out of the eleven honored wrestlers and also saw their coach Gene Moses appointed coach of the year.

Victor Bush of Colorado School of Mines was nominated for top honors in the heavyweight position. Vic is a junior majoring in metallurgy and is from Laramie, Wyo. Vic ended this season with a 10-8-1 season, with a record of 5-4-1 in dual meets and 1-2 in the CSC Tournament, 0-2 in the MIWA Tournament and a 3-1 in the RMAC Tournament.

Vic performed well until he suffered a "hip-pointer" late in the season wihch he did not recover from completely during the remainder of the season.

Varsity Gridders Upset Alumni 33-6

Saturday afternoon, May 9, the 10th annual varsity-alumni football game kicked-off at Colorado School of Mines with the varsity receiving the ball and marching 87 yards for a touchdown in 13 plays. Fullback Jim Taylor pushed through for the touchdown and Michael Flater kicked the extra point.

The score remained the same through the first half with the varsity gaining the ball three times and the alumni attempting two touchdown drives.

The second half was a different story for the alumni. They found themselves confronted with a outstanding varsity backfield who gained small yardages and touchdowns. At 11:01 remaining in the third quarter a pass to alumni member Jay Godley was intercepted and returned for a varsity touchdown by Don Welch, the pat failed and the varsity led 13-0. The alumni's quarterback Tom Garner a 1967 graduate then put together the drive which netted the alumni's only TD. Following a fumble on the 50 the alumni regained the ball and with backs Tom Garner '67, and Bill Watson '69 carried the ball to the one-yard line on a running attempt. The varsity regained their control and picked up one additional TD in the third quarter to maintain a 20-6 lead.

The fourth quarter again was dominated by the varsity with two TD's at 11:30 remaining Dan Sprouse hit the middle for one with Glen Sykes kicking the extra point, followed by the last TD with 7:52 remaining on the clock when K. C. Kollenkark carried a 12-yard pass for the TD and Glen Sykes made the final 33rd point.

CSM Athlete Scholars Recognized

Twenty-five scholar-athletes of Colorado School of Mines have been named to the Rocky Mountain Athletic Conference Academic Honor Roll, Harry B. Kniseley, Commissioner, announced recently.

Included in the honored group are 232 varsity athletes of the 15 RMAC member institution, who have maintained grade averages of "B" or better during their college careers.

"Athletes gain public recognition because of their conspicuous participation in sports, but many of them are as successful in the classrooms as they are in athletic competition," Kniseley commented.

Following is a list of Colorado School of Mines athletes who received the special recognition:

Cross Country: George Rux, Barry Sauve. **Basketball:** Tom Tulk. **Swimming:** Gary Krieger, Bob Wiley. **Wrestling:** Tom Comi, Fred Limbach, Tim McClure. **Golf:** John Belcher, Scott Minnick, Philip Johnson, William Server. **Baseball:** Truman King, Steve Luedders, Leon Piper, Steve Hile. **Track:** Emmitt Kraft, Steve Rakowski, Barry Sauve, Bill Server, Paul Culnan, Dave Towner. **Tennis:** Steve McFarland, Bruce Pike, Bob Spangler, Jim Flanagin, John Eulich.

In addition to the 25 athletes receiving RMAC recognition 31 additional Colorado School of Mines athletes were on the first semester honor roll maintaining a "B" or higher grade point average.

The athlete with the highest cumulative grade point was Roger Olsen, sophomore from Yuma, Colo., whose GPA stands at 3.86. Olsen was an offensive guard on last fall's varsity football team.

Other athletes outstanding were in the following sports:

Baseball: Fred Ciochetto, Bob Dearinger. **Basketball:** Michael Acosta, Donald Apt, Bob Dearinger, Leon Piper, Steve Luedders. **Cross Country:** Paul Culnan, Stephen Douglas. **Football:** William Arbegast, Randal Brocher, Patrick M. Claiborne, Richard Gardner, Steven Hile, Gary Hudiburgh, Roger Olsen, Randall Scott, Dennis Ulrich. **Golf:** Philip Hammond. **Swimming:** Walter Malone, Greg Siebers. **Tennis:** David Korrey. **Track:** Randal Brocher, Lawrence Brumwell, Stephen Douglass, Richard Kehmeier, Robert E. Watson. **Rifle:** Robert Wunder. **Skiing:** Robert Crewdson, William Pearson. **Soccer:** Lyle Bonham, Vasfi Erol, Heinz Hartmann, James Kohm, Steven Schuhurt, Mustafa Tasci.

Book Reviews

Worldwide Directory Of Mineral Industries

Uniquely prepared as a reference source, the **Worldwide Directory of Mineral Industries Education and Research** is an invaluable work on education and research in the mineral industries. With the tremendous sums of money spent on research today, one glaring need has become apparent—the need for communication between people throughout the world doing research in similar areas. Previously, this information was inaccessible without spending vast amounts of time and energy searching for who was doing what, where. Now, with the publication of this Directory, the dilemma has been remedied for the mineral industries. This storehouse of facts and figures enables educators, students, companies, and interested individuals to screen and obtain information on more than 4,000 current research projects from more than 500 institutions of higher learning in 68 countries.

Orders for this book at $35.00 per copy may be sent to Gulf Publishing Co., P. O. Box 2608, Houston, Tex. 77001. On orders from inside the U.S. include 55 cents for postage and handling; all orders outside the U.S. should be accompanied by payment; minimum postage is 75 cents for one book and 30 cents for each additional book.

Industrial Minerals Of Utah Shown On New Map

A new map of the industrial minerals of Utah has been recently released by the Utah Geological and Mineralogical Survey. Prepared by Hellmut H. Doelling, economic geologist of the Survey, the map shows where industrial minerals may be found in the State, whether the sites are developed or not and whether actively producing.

The map, printed in color, is 11"x16" with descriptive summaries of each locality printed on the back. Copies may be obtained at the Utah Geological Survey, 103 Utah Geological Survey Bldg., University of Utah, Salt Lake City, Utah 84112, for 35 cents or 50 cents prepaid. Mail orders should include the price of the map with the order.

Breaks Record In High Jump

Brett Bristol, a junior majoring in chemistry at CSM set a new school record May 2 in the high jump event at 6'7¼" while attending the Southern Colorado State College Invitation Track Meet.

Eleven teams were participating in the meet at Pueblo. Bristol won the event hands down, therefore allowing him to participate in the NAIA National Meet and the College Division meet of the NCAA. Both events will be held during the month of June.

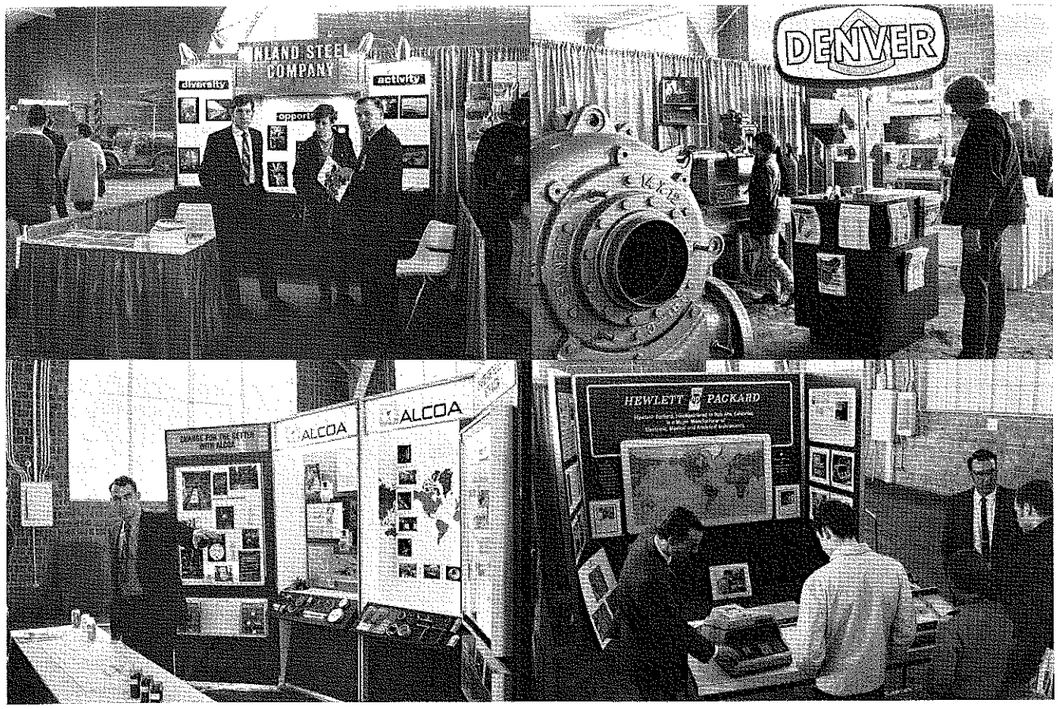
Brett broke his last year's record of 6'6¾" which he set during the 1969 season at Mines. His hometown is Brighton, Colo.

CSM Athletic Director On Selection Committee

CSM Athletic Director Fritz Brenecke has been appointed chairman of the 1970 College Division All-American Football Team Selection Committee within the district 6 of the coaches association.

The other two members of the committee are: Nate Harlan, Head Football Coach, St. Thomas University in Minnesota; and Ron Erhardt, North Dakota State University in Fargo.

This committee accepts nominations for all of the college division institutions in its district, screens the candidates and then sends final selections from this district to the overall chairman, Ted Dunn of Springfield College in Springfield, Massachusetts.



PRIZE-WINNING INDUSTRIAL EXHIBITS SHOWN ABOVE WERE PHOTOGRAPHED during the 36th Annual CSM Engineers' Day activities held April 17-18, 1970. First place award went to Inland Steel Co.; second, Denver Equipment Division of Joy Manufacturing Co.; third, Hewlett-Packard; fourth, Aluminum Company of America. The top two exhibitors received advertising space in MINES Magazine as a part of their award. Impressive displays from each of the Colorado School of Mines' engineering departments were set up in addition to the industrial and military displays in Steinhauer Field House. The keynote address by Gordon J. F. MacDonald is presented on pages 16-19 of this issue of the magazine.

Warner Recipient Of Class of 1939's Scholarship Fund

MICHAEL P. WARNER of Brush, Colo., is this year's recipient of the $100 award from the Class of 1939 Scholarship Fund. (Interest from the $1760 fund goes each year to an entering freshman selected by the CSM coaching staff.)

Mr. Warner graduated from Brush High School in 1969 and enrolled at Mines this fall. He is an All-State basketball player, standing 6'6" in height and led Brush High School last winter in the State Class AA Championship. He also participated in the Colorado High School All Star Game in Pueblo this past August. He graduated 11th in a class of 120, and his total over-all grade point average from high school is 3.57. He is married and has a small child.

Once we talked out our problems over coffee and cigarets. Now they are the problems.

Personnel Placement

THE COLORADO SCHOOL OF MINES ALUMNI PLACEMENT SERVICE functions as a clearing house for alumni and former students who wish to receive current information about employment opportunities for which they may qualify. It also serves the oil, gas, construction and related industries and many government agencies by maintaining current listings of openings they have for qualified engineers, technical and management personnel.

Companies needing qualified men with degrees in Geological Engineering, Geophysical Engineering, Metallurgical Engineering, Mining Engineering, Petroleum Engineering, Petroleum Refining Engineering, Engineering Physics, Engineering Mathematics, and Chemistry are invited to list their openings with the CSM Alumni Placement Service, Guggenheim Hall, Golden, Colorado.

Listed below are coded references to the graduates of the Colorado School of Mines who were available for employment at the time this issue of The MINES MAGAZINE went to press.

Client's Code Number	Degree	Age	Marital Status	No. of Children	Preferred Fields of Work	Locality Preferred	Languages Spoken
MN 18	Mining	44	M	2	Mining-Metals Mill	Colorado	English
MN 19	Mining	34	M	2	Mining Engineer	Western U.S.	English
MN 29	Mining	51	M	0	Sales Management	U.S.A.	English
MN 30	Mining	26	S	0	Mine Exploration or Heavy Equipment	Alaska/Western U.S.A.	English
MN 34	Mining	39	M	1	Mining Geology	Western USA/Foreign	English/Spanish
MN 35	Mining	45	M	6	Mining Engineering	Open	English
MT 41	Metallurgy	29	M	2	Metallurgical Engineering Management	U. S.	English
MT 42	Metallurgy	25	S	0	Sales or Technical Representative	Open	English
MT 43	Metallurgy	28	M	2	Metallurgical Engr./Nuclear Fuel Rod Mfg.	U. S. except N.E.	English
MT 44	Metallurgy	28	M	2	Mechanical Metallurgy	Open	English
MT 45	Metallurgy	33	M	5	Physical Metallurgy	Western U.S.A.	English
MT 47	Metallurgy	33	M	3	Mill Operation	West. U. S.	English
MT 48	Metallurgy	35	M	2	Development, Project Management	Colorado	English/Spanish
MT 49	Metallurgy	24	M	2	Project Metallurgy—Production Metallurgy Sales Eng.	Rocky Mt. Region	English
MT 50	Metallurgy	24	M	2	Project or Process Engineering	Western USA Rocky Mtn.	English
MA 05	Mining—Math	26	M	3	Operations research, Systems analysis		
GE 30	Professional Engineer	35	M	3	Engineering—Civil—Geology	Open	Thai, Spanish and English
GE 31	Professional Degree	25	S		Geological Exploration Development, Management	Western U. S. A.	English
GE 32	Geological Engr. N/A	35	M	3	Chief Mine Geologist or Senior Geol. Eng.	Western U. S. A. Will consider other	English
GE 34	Geol. Engr. Civil Eng.	39	M	3	Prefer Management	Open	English
GE 35	Geology	39	M	1	Mining Geology	Open	English
GE 36	Geology	43	M	1	Production—Mining or Non-metallic Processes	Western U.S.	English
GE 37	Geol. Engr.	42	M	3	Geological Exploration	Western USA/Foreign	English
GE 38	Geology	35	M	2	Mineral Prop. Evaluation Mine Manag. & Planning	Western USA/Foreign	English
GP 15	Geophyics	49	M	3	Petroleum Expl.	Rocky Mountains	English
GP 17	Geophysics	34	M	1	Geophysics	Colorado	English
GP 18	Geophsyics	23	S	0	No Mgmt. Trainee	Rky. Mtn.	English
GP 19	Professional Engineer	24	M	0	Mineral Exploration	Southwest U. S. or South America	English
PE 15	Petroleum	24	S	0	Reservoir Engr.	Rocky Mtn. Region	English
PE 16	Pet. Eng.	27	M	2	Prod. Engr.	Rocky Mtn., Canada or Alaska	English
PE 17	Pet. Eng.	34	M	4	Pet. Engr.	Open	English
PH 02	Physics	23	S	0	Engineering Physics	Rocky Mtn. Region	English
PH 04	Engr. Physics	27	M	0	R.& D. Engr. Marine Engr.	Coastal except N.E.	English
PR 11	Masters in P.R.E.	30	M	2	Management Systems	U.S.A.	English

Technical Societies

Nuclear Power Symposium

A symposium on the "Environmental Aspects of Nuclear Power Stations" will be held at United Nations Headquarters in New York Aug. 10-14. The symposium is sponsored by the International Atomic Energy Agency in cooperation with the Atomic Energy Commission. It will provide for the exchange of views on the health and safety aspects of nuclear power stations and on environmental problems of nuclear power.

Third Symposium on Coal Mine Drainage Research

The Third Symposium on Coal Mine Drainage Research, sponsored by the coal industry, was held at the Mellon Institute Auditorium, Pittsburgh, on May 19-20.

Mine Drainage is one of the major problems of the coal industry. The symposium gave coal industry leaders and other interested persons broad in depth looks at recent progress in mine drainage research.

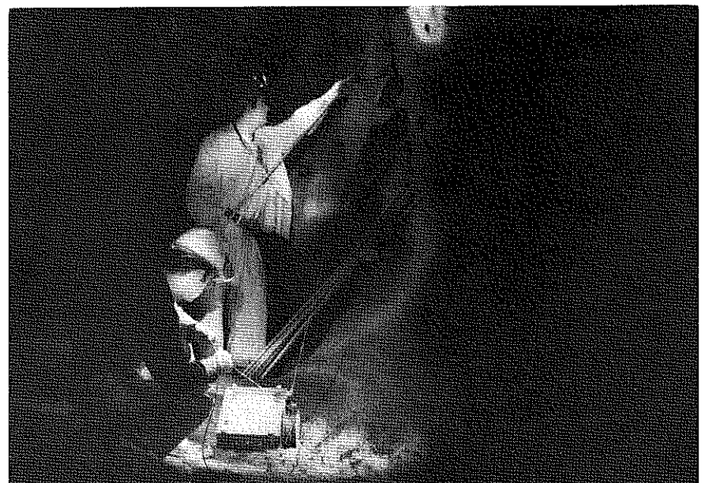
Dean Charles T. Holland of the School of Mines, West Virginia University, Morgantown, was chairman of the symposium committee. James F. Boyer, Jr., project scientist for Bitumimous Coal Research, Inc., Monroeville, Pa., was program chairman.

Survival Kit for Students Traveling to Europe

The Council on International Education Exchange has come to the aid of the student traveler with its new Survival Kit for Students Going to Europe. The Survival Kit is an information packet designed especially for the independent student traveler of the '70s who wants to see Europe as an insider.

The Survival Kit contains information on student hostels and restaurants; intra-European student flights, trains and buses; and general information to help the student plan his trip and maintain his budget. (To be eligible for many of these special student travel services, as well as other European discounts, the student needs an International Student or Scholar Identity Card which is also available from the CIEE.)

For information and assistance, write to: CIEE Student Travel Services, 777 United Nations Plaza, New York, New York 10017. The answer to a student's S.O.S. is here. "Survival" has never been so much fun.



Alumni Headliners

Reynolds

Reichert

Reynolds Promoted by U.S. Steel To Superintendent-Maintenance

JAMES F. REYNOLDS, E.M. 1961, has been appointed superintendent-maintenance, Western District Coal, U. S. Steel Corp., Dragerton, Utah. He succeeds John T. Maulsby, who has retired.

Mr. Reynolds, a native of Price, Utah, graduated from the Colorado School of Mines in 1961 with a degree in Mining Engineering. He began his career with U. S. Steel that same year as a management trainee. He was promoted to the position of electrical engineer in 1963, holding those responsibilities until this latest appointment.

Mr. Reynolds, his wife Nadean and children reside at 345 Carson Avenue in Dragerton.

Reichert Joins Australian Firm Of Consulting Engineers

STANLEY O. REICHERT, D.Sc. 1953, for the past nine years geologist and senior engineer in the Radiological Sciences Division, Savannah River Plant operated by DuPont for A.E.C., has joined the firm of Layton and Associates Pty. Ltd., consulting geologists, mining engineers, and metallurgists, Australia. His headquarters will be in Pertha, Western Australia.

Deneke

Dutton

Donnelly

Deneke Appointed Manager For Division of U.S. Gypsum

RICHARD W. (DICK) DENEKE, E.M. 1943, was recently appointed manager, Manufacturing for the Southern Construction Products Division of the United States Gypsum Co., an international building materials manufacturer. He has the responsibility for seven plants within the Southern Division.

Mr. Deneke is a graduate in Mining Engineering from the Colorado School of Mines and was a member of Sigma Alpha Epsilon Fraternity. He was also elected to Tau Beta Pi, Blue Key, and Scabbard and Blade.

During World War II, Dick served as a First Lieutenant in the U. S. Army Engineer Corps. Immediately after the war, he joined U. S. Gypsum at Farnams, Mass., as a quarry engineer. Before being appointed manager-Manufacturing, Mr. Deneke was Works manager at Plaster City, Calif., and Heath, Mont.

Mr. Deneke is married to the former Karen I. Larsson, and they reside at 1130 Winding Creek Trail in Atlanta, Ga., with their two daughters, Tina, 10, and Suzy, 6.

Donnelly Receives Promotion At CF&I Steel's Palmer Plant

THOMAS K. DONNELLY, Geol.E. '59, has been appointed assistant superintendent-Industrial Engineering at CF&I Steel's Palmer Plant, Palmer, Mass. He had been a senior industrial engineer.

A native of Pueblo, Colo., Mr. Donnelly attended the Los Angeles City College and in 1959 received a degree in Geological Engineering from the Colorado School of Mines. He will receive a Master's degree in Business Administration from Western New England College this spring.

Mr. Donnelly joined CF&I Steel Corp. at the company's Pueblo Plant in 1962. He was transferred to the Palmer Plant in 1966.

Married with three children, he makes his home in Wales, Mass.

Dutton Supervising Engineer For Humble Oil and Refining

WILLIAM G. DUTTON, P.E. 1954, of the Southwestern Division office of Humble Oil & Refining Co. in Midland, Texas, has recently been promoted to the position of Division supervising engineer. This promotion is in recognition of outstanding achievement, particularly in the field of reservoir engineering.

Mr. Dutton is a native of Fort Collins, Colo., and graduated from Colorado School of Mines in 1954 with a degree in Petroleum Engineering. He worked briefly at Grand Isle, La., before going on military leave of absence. Upon returning to Humble he was assigned to a one year training program at Headquarters in Houston, Texas.

Since June 1957, Mr. Dutton's assignments have covered various phases of reservoir engineering activity in the Division office and other areas of West Texas and New Mexico.

In February 1967, he was assigned as senior supervising engineer in the Division Reservoir Engineering group —the position he held until his recent promotion. He is a member of the Society of Petroleum Engineers of AIME.

Appetizers are those little things you keep eating until you lose your appetite.

Melickian

Lea

G. E. Melickian and R. L. Lea Admitted to Partnership In Dames and Moore

GARY E. MELICKIAN, Geol.E. 1959, and RICHARD L. LEA, Geol.E. 1959, have been admitted to the partnership of Dames & Moore, international consulting engineering firm in the applied earth sciences.

An employee of Dames & Moore for 10 years, Mr. Melickian is presently located in the firm's Los Angeles Executive Offices. Formerly, he was assigned to its Los Angeles, Salt Lake City, and New York engineering offices. He has directed engineering, geologic, and geophysical investigations for harbor projects, industrial development, dams, mining facilities, and nuclear power plants in the United States, Caribbean, Mexico, and Scandinavia. He was transferred to the firm's Executive Offices a few years ago and since has functioned as its quality assurance engineer and special projects engineer. He is currently serving as manager of public relations and as chairman of the firm's research and development committee.

A registered geologist and certified engineering geologist in the state of California, Mr. Melickian is a member of the Society of Mining Engineers of the AIME, American Institute of Professional Geologists, the Associate of Engineering Geologists, and several other professional organizations. He is the AIME representative to the American Geological Institute House of Society Representatives and, two years ago, served as the delegate of the Association of Engineering Geologists to the International Geological Congress held in Prague, Czechoslovakia. He formerly served as president of the Southern California Section of the Colorado School of Mines Alumni Association.

Richard L. Lea has been general manager of Dames & Moore's Spanish subsidiary since 1967. Prior to this he served as chief engineer in the firm's Atlanta office and as project geologist in its Salt Lake City office.

Since joining Dames & Moore eight years ago, Mr. Lea has traveled extensively throughout the world on numerous projects, particularly in the fields of water resources, dams, and water supply. He has directed the engineering and geologic investigations and design for several earth dam structures in the United States and Spain. Mr. Lea has been involved in numerous environmental studies for the siting of nuclear power plants and subsequent testimony before the United States Atomic Energy Commission during hearings for licensing nuclear reactors for operation. His work presently involves him in consulting assignments throughout Spain, other parts of Europe and North Africa.

Mr. Lea is a member of the American Society of Civil Engineers, Society of Mining Engineers of AIME, U. S. Committee on Large Dams and the International Society for Rock Mechanics. He is a registered civil engineer in the state of Georgia.

Prof. Leonard E. Olds of SDSM&T Develops Steel-Making Process For Small-Capacity Plants

LEONARD E. OLDS, Met. E. 1949, associate professor of Metallurgy at South Dakota School of Mines & Technology, believes there is an excellent opportunity for industry to utilize the taconi e deposits in South Dakota for steel making.

The first steel made from native taconite in South Dakota was smelted and poured May 12, 1970, in a makeshift foundry at SDSM&T in Rapid City, S.D. "We have developed a steel-making process which should be economically feasible for small-capacity plants," Professor Olds stated.

The taconite used was from Hat Mountain, west of Rapid City. It was concentrated by a Tech student, Cheng Hsin Wang, who is working on his master's.

Reduction was by sub-bituminous coal from Gillette, Wyo., and the high carbon steel-to-be was heated in an electric arc furnace.

Professor Olds, a 1949 Colorado School of Mines graduate, joined the SDSM&T faculty September of 1969. For 10 years he was with the Strategic Udy Co., Niagara Falls and Ontario, where he was vice president of research.

Earlier he taught and was engaged in research at the University of Denver. From 1956 to 1959 he did metallurgy research at Battelle Memorial Institute.

B. G. Baugh and S. W. Schoellhorn Elevated to Vice-Presidents Of Seismograph Service Corp.

BILLY G. BAUGH, Geop. E. 1950, and **S. William Schoellhorn**, Geol. E. 1942, have been elevated to vice presidents of Seismograph Service Corp. of Tulsa, Okla. The announcement came from E. D. Wilson, president and chief executive officer.

"Baugh will be responsible for foreign seismic land operations supervised from the United States, while Schoellhorn will remain in charge of research and development," Wilson stated. "The former," he continued, "was elected assistant vice president of foreign operations early last year but continued expansion of our foreign activities necessitates additional emphasis in this area of our business.

"Schoellhorn's promotion is made in connection with our intensified programs in research and development designed to maintain required technological levels."

Baugh joined SSC in domestic exploration after receiving his professional degree in geophysical engineering from Colorado School of Mines in 1950. After a tour of U. S. Navy service, he returned to the company, serving in increasingly important geophysical positions throughout the world. He was manager of Libyan operations from 1964 to 1966 when he was made staff supervisor of foreign operations in the Tulsa headquarters.

Also an alumnus of Colorado School of Mines, Schoellhorn received his Geological Engineering degree in 1942, and did graduate study in geophysics at California Institute of Technology in 1949 and '50. He joined SSC as an instrument operator on a seismic crew. He advanced to party chief in Venezuela and later became area supervisor in domestic exploration. He then became senior research engineer in charge of seismological research and was named research director in 1958. In 1963, he was elected assistant vice president of research and development.

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Letters

Maxwell House
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Elmsford, New York 10523
May 12, 1970

Dear Mr. Kaanta:

It is always a pleasure to read The Mines Magazine. I very much appreciate the high standards that you maintain.

A minor note: The listing for my new address should be Editorial Dept., Pergamon Press, Inc., Fairview Park, Elmsford, N. Y. 10523.

It might be of interest that, among our publications (over 600 titles per year and 215 journals), we have **Electrical Methods in Geophysical Prospecting** by G. V. Keller (Colorado School of Mines) and F. C. Frischknecht (U.S.G.S.).

As project editor for the Pergamon Unified Engineering Series, I remain most interested in engineering education. It was therefore that I took note of Jack Rivkin's recent letter to *The Oredigger*. I agree that "the school seems to be slipping farther and farther behind the times." My criticism would have nothing to do with the hope of turning Mines into an MIT. But there is a need to bring Mines out of its isolation, to remove delusions of exclusiveness, and to put the needs of engineering students (in the context of today's restructuring of knowledge) before the needs of the mineral industry. So much for generalities. Let me recommend **A Study of a Profession and Professional Education** by Dr. A. B. Rosenstein (copy may be obtained from Dr. A. B. Rosenstein, Reports Group, School of Engineering and Applied Sciences, UCLA, Los Angeles 90024). Permagon Press has published Davenport and Rosenthal **Engineering: Its Role and Function in Human Society.** I am sending you a complimentary copy for your review.

I would like to express my regret at the resignation of President Orlo E. Childs. His seven years at Mines were surely the most dynamic that we have yet known, both in the growth of the School and in the development of the curriculum.

Cordially,
Henry A. Paasonen
Geop.E. 1966
Project Editor

Lee M. Yarberry, E.M. 1948, who has been employed by Dillingham Corp., has been appointed vice president and general manager of Ocean Industries, Inc., at Ft. Lauderdale, Fla. The company owns exclusive concessions on a huge Aragonite deposit in the Bahamas and they will begin the initial stages of development during this year with production to follow in the second quarter of 1971.

2, Boulevard Mohamed V
Alger, le 7 Mai 1970

Dear Wendell:

As always when one moves some things are neglected. In this case it's my "MINES Magazine." Please find enclosed my check for $20 which should cover the situation.

My home address is: 127 Salah Bouakir 8° étage ALGER.

Algeria, at least on the Mediterranean coast, is the garden spot of North Africa and the family is truly enjoying the attractions of the area.

Operations in the Sahara are all at once stimulating and demanding.

I'm looking forward to the arrival of the magazine.

Regards,
J. G. Cowan, P.E. 1949

Estudio de Minerales,
N. U., Guatemala
February 2, 1970

Colorado School of Mines
Library
Gentlemen:

It is my great pleasure as an alumnus of the Colorado School of Mines (G.E. 1955) to donate to the library of the University the map and publication relating to "Metallogenesis of Central America." Even though it is written in Spanish I do hope it will be a significant contribution to the knowledge of the distribution and genesis of ore deposits in North America.

The map and text was published with the aid and support of the Central American Institute of Industrial Research (ICAITI) and the Regional Office for Central America and Panama (AID).

To make better use of the map and text Iwould appreciate it if you exhibit the map at the library and publish a small note in the "Oredigger" for the students knowledge.

Enrique Levy, Geol.E. '55

Alumni Business

MEETING—BOARD OF DIRECTORS
Colorado School of Mines Alumni Foundation
April 23, 1970

MEETING was called to order by President Hal Addington at 8:40 p.m. Those present were: Hal Addington, president; Warren Prosser; Ken Nickerson; Neal Harr, secretary; Donald Craig, director; Bob Magnie, treasurer; Harrison Hayes, vice president; Wendel Fertig, executive secretary.

The minutes of March 19, 1970, meeting were reviewed and approved. The financial statement was presented by Wendell Fertig; at this time we are approximately $3,500 ahead of condition at this time last year. Gain was largely the result of increased memberships, directory sales, and magazine advertising.

President Addington requested that Wendell Fertig provide the board with a job description and schedule of yearly activities of the Executive Secretary, as well as other personnel of the alumni office.

OLD BUSINESS

No replacement for Membership Committee Chairman has been selected as yet, but contact is to be made before next meeting.

NEW BUSINESS

Honorary Membership for Dr. Childs was discussed, moved and approved. Nominating petition will be circulated prior to next meeting.

Dr. Robert H. Carpenter was nominated for Honorary Membership, seconded and unanimously approved.

Freshman scholarships granted by the Alumni Foundation for the past three years were reviewed by Donald Craig and Neal Harr as follows:

By resolution of the Board of Directors, June 14, 1966, three one-year scholarships in the amount of $300 each are to be awarded to Freshmen by the CSM Alumni Foundation. The funds for these scholarships are to be provided by the interest derived from the Student Emergency Loan Fund. Thus far, three scholarships were awarded for the school years 1967-68 and 1968-69, and four scholarships for 1969-70. The scholarship monies were paid at the rate of $150 at the beginning of each semester of the freshman year and were applied toward tuition.

Further information and recommendations will be presented at the next meeting. It was moved, seconded, and approved that four $300 Freshman Scholarships be awarded for the 1970-71 school year.

The annual banquet will be held at the Denver Athletic Club on Thursday, May 28, 1970, beginning at 6:30 p.m. Reservation cards will be mailed to all alumni on April 29, 1970.

Wendell Fertig made a brief report on the next issue of The MINES Magazine.

The next board meeting will be held May 21, 1970.

Meeting adjourned at 9:20.

Mineral Industries

Calcinated Alumina Silicate Plant Being Constructed

Operation of one of the world's largest plants for the production of Calcined Alumina Silicate Products has been announced by Robert E. Nelson, vice president and general manager of C. E. Minerals, King of Prussia, Pa. Located on over 800 acres near Andersonville, Ga., the new facility is known as the Mulcoa Plant.

Raw material deposits of kaolin, bauxitic kaolin and bauxite owned or under lease by Mulcoa are estimated to be in excess of 50 million tons of reserves. The completely automated plant, operating from a central instrument room, will be capable of producing approximately 350 tons of bauxite ore on a 24-hour, seven-day-a-week basis to supply some of the requirements of refractories, foundries, and ceramics in the United States, France, West Germany, Italy and Japan.

Bullion Monarch Mill in Nev. Ships Silver Concentrates

Start-up of its new million dollar silver flotation mill located at Austin, Nev., was announced by Robert D. Morris Sr., chairman of the board of Bullion Monarch Co. (Salt Lake Stock Exchange). The mill is now operating on a 24-hour a day scheduled and regular shipments of concentrates are being made to the smelter at Tooele, Utah.

"We are processing 200 tons of ore per day," Mr. Morris said, "with an average yield of five ounces of silver per ton from the dump materials."

Staking for Non-Metallics Within Rampart Withdrawal

Questions have been raised about the staking for non-metallics in the Rampart power withdrawal, an area of nearly 9,000,000 acres.

When Secretary Udall signed Power Site Classification No. 445 on January 5, 1965, the Rampart Dam withdrawal became classified as a powersite. Powersites are open to staking. Such a classification is not affected by the "Land Freeze" (Public Land Order 4582) and thus, by statute 30 USC 621, locatable minerals, metallic and non-metallic, may be staked within the Rampart withdrawal.

New Milling—Concentrating Facility Being Constructed By International Nickel

A new $80 million ore-crushing and concentrating facility is being constructed at Copper Cliff, Ont., by The International Nickel Company of Canada, Limited, to increase its milling capacity, provide maximum recovery of pyrrhotite, upgrade the metal content of the smelter feed and to increase over-all metal recovery. The mill is part of a general expansion and modernization program begun by the company in 1966.

The new facility will replace the obsolete receiving, crushing and grinding equipment that handles ore from those Sudbury District mines that do not have their own internal milling facilities. These include the Clarabelle, Copper Cliff North, Garson, Murray and Totten mines, as well as the No. 5 shaft of the Creighton mine. In addition, it will provide additional capacity to handle ore from the Kirkwood and Copper Cliff South mines when they come into production. Operation will begin in late 1971.

RECENT GRADUATE

Industrial mineralogist for refractory product research. Work with ceramic engrs. Small midwest town. Good pay/benefits. Resumes invited. EMPLOYMENT EAST, Box 992, Groton, Conn.

141 Million Tons of Steel Produced by U. S. in 1969

The American steel industry produced a record 141 million tons of raw steel in 1969—close to seven million tons greater than the previous high, set in 1966, about ten million tons more than the industry produced in 1968.

Shipments of about 94 million tons of steel products to customers also set a new record. The industry's previous high in shipments was 92.7 million tons, set in 1965, and 1969's shipment exceeded those of 1968 by some two million tons. Preliminary calculations also indicate that the nation's total consumption of steel, both domestic and foreign, was equal to, if not better than, the best previous year of 1968, when steel consumption was 103 million tons.

A significant feature of the 1969 steel picture was the aggressive response by American producers to the booming worldwide demand for steel. Exports of American-made steel to foreign countries amounted to approximately five million tons in 1969—about double what was shipped abroad in 1968.

At the same time, flourishing foreign steel markets, coupled with the voluntary arrangements of European and Japanese producers to limit their shipments into the United States, reduced steel-mill products imported into this country to about 14 million tons in 1969—down from the pinnacle of 18 million tons that were imported in 1968. If the world market for steel continues to grow as it should, opportunities for American steelmakers should take on new dimensions.

Primarily because of inflation's effect on costs, the profit earned by the steel industry last year, based on available data, will not be as good as in 1968 either in dollar volume or as a return on sales.

The outlook for industrial activity in the first half of 1970 would appear to be essentially a plateau, with a resumption of economic growth in the second half of the year. Steel consumption in the United States under such conditions would then be about the same in 1970 as in 1969, or perhaps moderately lower.

Looking at the world market for steel, current signs indicate it should continue strong at least through the first half of 1970. Although worldwide demand for steel could soften somewhat as the year wears on, imports of steel into this country, and export opportunities for American producers, should not be significantly changed from those of 1969.

Then there was the cross-eyed discus thrower: he didn't set any records, but he sure kept the crowd alert.

Executive Secretary

Col. Fertig

NEW PRESIDENT OF COLORADO SCHOOL OF MINES

THIS column was written in mid-May and consequently much action may take place before it reaches publication, but at present I understand that there has been no definite choice for a new president for the Colorado School of Mines. This is an extremely important position, particularly during the present trying times, and every effort should be made to select the best man possible. The CSM Alumni as a group has not made a recommendation.

However, many of our members have submitted names directly to the Board of Trustees, and I hope that this will continue.

The Board of Trustees has called upon the faculty as well as the student body to submit recommendations. The Alumni as a group probably offers a better cross-section, geographically, than either of the other two groups since our members are so widely scattered through industry.

If you have any names to suggest write directly to President, Board of Trustees, Colorado School of Mines, Golden, Colo. 80401.

NEED TO COMMUNICATE WITH OUR MEMBERS

Recently a member from Calgary talked to Hal Addington, president of the CSM Alumni, saying that he was out of touch with the school and would appreciate knowing more about what is happening. There is no question that there is a lag in communication between our office and the widely scattered members of our organization. It is also true that many members living in this immediate area are unaware of things that happen. As a result of the suggestion, an effort will be made to carry more information in the Magazine so that our members will have ready access to it. As a suggestion I have asked Pres. Addington to write a brief report for publication each month in the Magazine.

Under current conditions, the only way that news can be given our members is through the Magazine. Of course this implies that you are willing to read the Magazine, and this should follow if we are willing to expand the coverage for you. A suggestion for special mailings have been made, but we simply do not have the funds nor the capability to put out mailings that frequently. Average cost of bulk mailing is 25 cents per addressee. Further, it has been our experience that as the number of mailings increase in the franked envelopes the more apt the letter is to land in the wastebasket.

Correspondence is an expensive business, but I do try to answer personally each letter that is received. Sometimes, due to the press of other affairs, the answer may be delayed, but eventually it is sent out. I have not taken the trouble to analyze the cost of answering these letters, because it is more important to answer them than to contemplate their cost. Recent business studies in other fields indicate that each personal letter written by a firm costs approximately $250.

NEWS ABOUT LOCAL SECTIONS

We are frequently disturbed by the lack of information from Local Sections, and we are most careful to print any information received. It is hoped that by increasing our attempt to communicate that it will cause a reciprocal action by those Miners who live away from Golden and with whom we are most anxious to keep in contact.

Personal visits to the individual sections is the best method of communication but this has become more difficult during the past year or two. An attempt will be made to increase the number of visits during 1970.

This matter of communication is a two-way street, and we hope that you will assist in every way possible so that we will be able to give you the information that you need as promptly as possible. It will be necessary for you to read the Magazine. Before you receive this Magazine, we will have moved the office from Guggenheim to the new gymnasium. The entire interior of Guggenheim is to be torn out and the building renovated, in order to provide additional and better planned office space. The first reports were that the construction would be completed within four months, but now it is very doubtful that we will be able to move back to Guggenheim before about February 1971.

If you come to Golden looking for us this summer come over to the new Gym as we will be located on the main floor and will be most happy to welcome you there.

PERSONAL

I think that the membership is entitled to an explanation as to the reason for my absence from the office for several weeks. In early April I entered the hospital to have a cataract removed and now, six weeks later, I am planning on returning to my office for the first time. The operation was a success, but it did take me away from the office and many visitors who called on me should know the reason why I was absent.

As Executive Secretary it is only proper that consideration should be given to finding a replacement for me sometime during the next two or three years. It is not critical at the moment but it is something that should be done. There are several reasons for this: some of the undergraduates feel that I am out of step with present day events and this may be a possibility; certainly, I do not understand the actions taken by some students on the campuses of our major universities. Fortunately our own undergraduates seem to be a different breed.

Further than that, I have served 10 years as Executive Secretary and feel that it is time for a change. The organization is in good financial condition, and a change could be phased over a period of time while I am still in Golden and in good health.

Since these changes should be planned, I think it is well for the membership to be aware of the fact that something will have to be done within a period of time and therefore thought should be given to choosing my successor.

The Board of Directors of CSM Alumni are aware of my feelings and will welcome any suggestions that you may have. Unfortunately we cannot afford to pay the going rate of salary for a full-time secretary. It is a position which requires at least half of the salary be your continued interest in Mines.

From the Local Sections

Section news should be in the Alumni Office by the 20th of the Month preceding Publication.

SECTION	PRESIDENT	VICE-PRESIDENT	SECRETARY-TREASURER	TIME AND PLACE OF MEETING
Alabama Birmingham			Wm. Haynes, '54	On call of the president.
Alaska Anchorage			Reginald S. Y. Lee, '67 628 E. 5th Ave., Anchorage 99501	
Arizona Arizona	William E. Saegart, '53	Robt. A. Metz, '55	James D. Sell, '55 2762 W. Holladay St. Tucson, Ariz. 85706	Annual Meeting, Dec. 7, 1970, Western Motel, Tucson.
California Bay Cities	Carl Foget, '61	Dave Strandburg, '61	Tom Aude, '62 54 Woodford Drive Moraga, Calif. 94556	Meetings held on call of the Secretary.
Santa Clara Valley			Stanley Y. Ogawa, '53	
Sacramento	Gail Penfield, '56		F. B. Sweeney, '57 6619 Auburn Blvd., Citrus Heights	
San Joaquin Valley	R. A. Ganong, '47		B. A. Ellison, '61	
Southern California	Dick Richards, '62		Neal Schmale, '68, Sec.	
Colorado Denver	A. E. "Ted" Scep, Jr., '68	Hal Kellogg, '55	Jack Dressel, '50	Luncheon meeting held third Tuesday of each month, Denver Press Club, 1330 Glenarm Pl.
Grand Junction	Arch F. Boyd, '26	Robert H. Sayre, '34	Robert F. Barney, '35	
District of Columbia Washington	A. A. Wyner, '25	Louis DeGoes, '41	Charles T. Baroch, '23 2001 N. Daniel St. Arlington, Va.	Regular meeting at noon, second Tuesday of each month at the Shrine Temple, 1315 K St. N.W.
Illinois Great Lakes	C. R. Fitch, '49 7915 Exchange Ave. Chicago 17, Ill.			
Kansas Wichita	Francis Page, '39		James Daniels, '51 307 Schweitzer Bldg., Wichita, Kans. AM 5-0614.	Meetings called by secretary. Contact secretary for date of next meeting.
Louisiana New Orleans	Charles Tyler, '53	Joseph L. DuBois, '50	Monie Richard, '60 Pan American Petr. Corp. P.O. Box 50379 New Orleans, La. 70150	Regular luncheon meetings — last Wednesday of the odd-numbered month except July.
Lafayette	John J. Wallace, '51	Edward J. Gibbon '68	Stephen D. Chesebro, '61 P. O. Box 51345 Lafayette, La. 70501.	Regular luncheon meetings at Lafayette Petroleum Club on fourth Thursday of each month.
Minnesota Iron Ore Range	Paul Shanklin, '49			
Missouri St. Louis	H. A. Dumont, '29 227 Crane St. Edwardsville, Ill.			
Montana Butte	John M. Suttie, '42 Continental Dr. Butte			
Nevada Northern Nevada	Paul V. Fillo, '40	H. R. Fitzpatrick, '36	James B. Bright, '52 1450 E. 2nd St. Reno, Nev. 89502	Meetings held four times per year at call of the Secretary.
New Mexico Carlsbad	John Magraw, '53			
Four Corners	Lou Amick, '50	Al Loleit, '50	N. E. Maxwell, Jr., '41 405 S. Church St. Aztec, N.M. 87410	Special meeting at the call of the president.
New York New York	Robt. B. Kennedy, '33	Board of Governors: Ralph Hennebach, '41 C. D. Michaelson, '32 C. Beilm, '34 R. B. Kennedy, '33	E. T. Benson, '33 1175 Broadway, New York, N. Y.	Meetings on call every month or six weeks from September to May, usually at Uptown Mining Club, 49th and Park Ave.
Ohio Central Ohio			Raymond M. Schatz, '35 Battelle Memorial Institute Columbus	
Cleveland	Bob Garrett, '45	Carl Nowak, '62	Richard Pitney, '60	Meetings held on call of president.
Oklahoma Bartlesville	G. T. McIntyre, '30	Bill Fredrick, '56	Charles Strong, '58 Box 336, Bartlesville, Okla.	Regular meetings held every Tuesday at noon, YWCA, 411 S. Johnston St. After September, group will meet every Friday.
Oklahoma City	Ed Johnson, '49 844 First Nat'l Bldg.			Regular meeting held at call of the president.
Tulsa	Todd C. Storer, '47		Jerry McLeod, '57 1708 East 60th Pl. Tulsa, Okla. 74105	Meetings held at call of the president.
Oregon Lower Columbia River Basin	Michael DiLembo, '58	D. H. Griswold, '30	Wendell Cloepfil, '62	On call of the president.
Pennsylvania Eastern Pennsylvania	Samuel Hochberger, '48	Arthur Most, Jr., '38 1345 Woodland Cr., Bethlehem		
Pennsylvania-Ohio	Vincent G. Gioia, '56		David P. Rihl, '58 Dravo Corp., Pittsburgh and Terrace Rd., Carnegie, Pa. 15106	Meetings held first Wednesday of each month (noon), Cafe "B," Golden Triangle YMCA, 4th and Wood Sts., Pittsburgh.
Texas Coastal Bend	Ray Gonett, '52	Charles R. Russell, '54	Irwin M. Glasser, '43 Humble Oil & Regining Co. Corpus Christi, Tex. 78401	Luncheon Meeting — First Wednesday of each month at the Petroleum Club.
El Paso	Peter A. DeSantis, '51	William F. Dukes, '50	L. G. Truby, '48 4320 O'Keefe Dr. El Paso, Texas 79902	Meetings held on last Wednesdays of January, March and May. Special meetings on call.
Houston	Ronald E. Diederich, '57	Edward B. Reynolds '66	James K. Applegate, '66 Marathon Oil Co. 2300 W. Loop, South	Luncheon meetings held at 12 noon on first Thursday of each month at White Horse Cellar, 1211 Fannin St.
Permian Basin	Hal Ballew, '51	Harry B. Hinkle, '59	Al Wynn, '65 4313 Princeton, Midland, Tex. 79701	Meetings held in Jan., Mar., May, Sept., and Dec.
Dallas-Ft. Worth	Harold E. Potter, '27	Dewey D. Bowling, '49	Peter A. MacQueen, '50 P.O. Box 2050 Ft. Worth, Texas 76101	Meeting held on call of president.

Four Corners Section Announces Election of New Officers

The Four Corners Chapter of the Colorado School of Mines met at the Glencliff Motel in Farmington, N.M., on April 23, 1970.

Miners present were: Dick Scanlon '38, Ray Will '68, Ken Gibbs '44, Doug Farris '64, Lloyd Chism '64, Allen Loleit '50, M. L. Seelinger '50, Norm Maxwell Jr. '41, Lou Amick '50.

Election of officers was held with the following results: President, Lou Amick; vice president, Al Loleit; secretary-treasurer, N. E. Maxwell Jr.

A letter from Ken Nickerson was discussed with the members. An Alumni was appointed to visit each of the four high schools in this area with the purpose in mind of trying to get outstanding athletes and scholars interested in going to Mines.

Meetings of this Chapter will be held as called by the president.

N. E. Maxwell Jr., Sec.-Treas.

Arizona Section Spring Picnic

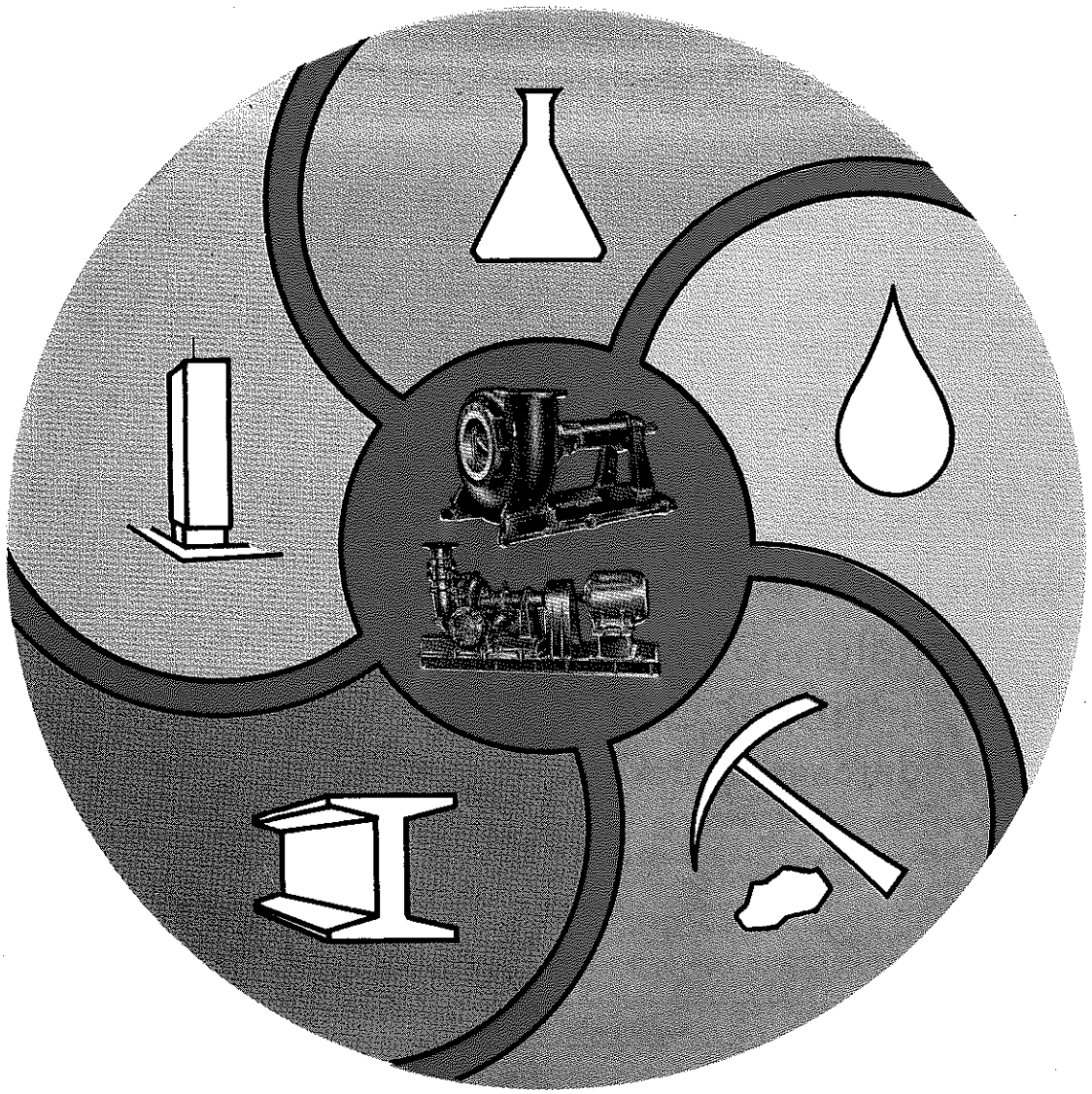
Members of Arizona Section enjoyed a sun-filled Spring picnic on Sunday, May 17, with the participation of 35 adults and 14 children. Following a short business meeting, at which time W. E. Saegart was elected president, and R. A. Metz, vice-president, of the Arizona Section, the group adjourned to the home of Past President Guerdon Jackson, where swimming was enjoyed along with continued fellowship. Plans are now in progress for the annual luncheon meeting to be held during the Arizona AIME meeting on Dec. 7, 1970.

James D. Sell, '55, Sec.-Treas.

Advertisers' Listings

People go on vacation to forget things, and when they open their bags, they find out they did.

SECTION	PRESIDENT	VICE-PRESIDENT	SECRETARY-TREASURER	TIME AND PLACE OF MEETING
South Texas			William A. Conley, '19 1515 Haskins Rd. San Antonio	Meetings held at 7 p.m. on first Thursday of February, May August, November at Old Town Inn, 416 8th St., San Antonio.
Utah Four Corners	See N.M. for officers			
Salt Lake City	Allen D. Trujillo '62	Wallace W. Agey, '48	Carl D. Broadbent, '61 5750 Glenbrook St. Salt Lake City, Utah 84121	Four meetings annually on dates set by officers
Washington Pacific Northwest	Sidney B. Peyton, Jr., '54		Boyd Watkins, '64 10427 Aqua Way S. Seattle, Wash. 98168	
Eastern Washington			Arden Bement, '54	Meetings on call of president; annual August picnic.
Wyoming Central Wyoming			George S. Rogers, '59 3209 Aspen Drive Casper, Wyo. 82601	
Canada Calgary	Richard C. Siegfried, '50 Canadian Superior Oil Ltd. 703 6th Ave., Calgary Tel.: 267-4110 Local 429			Calgary Section meets for a noon luncheon on the 3rd Monday of Sept., Nov., Jan., Mar., May—at Calgary Petroleum Club. Visiting alumni invited to attend.
France	Resident or visiting alumni may contact Bernard Turpin, '60, 33 Rue de la Tourelle, 92-Boulogne, France.			
Libya	Haldon J. Smith, P.E.53, Corresponding Secretary, Derbasi-Geode Co., P. O. Box 529, Tripoli, Libya.			
Peru	Martin Obradovic, '53			Meetings first Friday of each month (April thru December), 12:30 p.m., Hotel Crillon. Other meetings on call
Philippines Baguio	Francisco Joaquin, '26			
Manila	J. R. Kuykendall, 41	Jesus Jalondoni, '40	M. E. Natividad, '40 c/o Northern Motors United Nations Ave., Manila	Meetings held at noon, second Tuesday of each month.
Puerto Rico	Resident or visiting alumni may contact L. L. Hagemann, '60, Apt. 17, El Monte Apartments, Avenida Munoz Rivera, Hato Rey, Puerto Rico.			
Turkey Ankara	Alumni visiting Turkey contact Ferhan Sanlav, '49, Turkiye Petrolleri A. O. Sakarya Caddesi 24, Ankara, Telephone 23144.			
Venezuela Caracas	Z. Sancevic, '57	Jean Pasquali, '60	Ian Achong, '58 Cia. Shell de Venezuela Aptdo. 809, Caracas	



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