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SOURCES OF INFORMATION ON ROCK PHYSICS

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INTRODUCTION

This current literature review pertains to the field of rock physics, rock mechanics, wave propagation and other related subjects. The report has been divided into the following general catagories: Physical properties, Rock deformation, Loading, Engineering applications, Seismology, Wave propagation, and Instruments and methods. In each section the articles are arranged alphabetically according to author. Unavoidably, the sections include references which, subject-wise, may overlap into other divisions. Cross references for subjects, however, are not given. Grouped separately are titles selected from the Monthly Index, Russian Accessions of the Library of Congress.

As with previous reports, titles are from material which was made available at the Colorado School of Mines, Arthur Lakes Library during February 1962. Author's abstracts or introductions are in quotation marks and, where time has permitted, the sections treated in the main article are also noted.

In the case of foreign articles, where both are available, the titles appear in the language of the article followed by the translation. When the author's name is followed by two dates, 1957 (tr. 1960), the first is the publication date and the other the date of translation.

The abbreviations for publications are those used by the U. S. Geological Survey in Geophysical Abstracts and also, those listed by the Library of Congress in the Monthly Index of Russian Accessions.

(continued on next page).

Abbreviations:

ARPA — Advanced Research Projects Agency
Washington 25, D. C.

ATS — Associated Tech. Service, Inc.
P. O. Box 271
East Orange, New Jersey

OTS — Office of Tech. Services
Department of Commerce
Washington 25, D. C.

SLA — SLA Translations Center
The John Crerar Library
86 East Randolph Street
Chicago 1, Illinois

* - Descriptors marked with an asterisk will be included in the cumulative indexes of the publications.

PHYSICAL PROPERTIES

Amyx, J. W., and Bass, Daniel W., Jr., 1961(?), Properties of reservoir rocks in Petroleum production handbook: McGraw-Hill Book Co., Inc., New York, 2 v., 1,872 p. Title and review in Jour. Petroleum Technology, v. 14, no. 1, p. 58. January 1962. T. C. Frick, editor.

Bernhard, Ruhfus, 1961, Investigation of the influence of the dimensions and layering of rock specimens upon the compressive strength: Colorado School of Mines Mining Engineering Thesis 916.

Dickson, G. O., 1962, Thermoremanent magnetization of igneous rocks: Jour. Geophys. Research, v. 67, no. 2, p. 912-915, 2 figs., 6 refs. February.

Fairhurst, C., 1961, Laboratory measurement of some physical properties of rock in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 105-118, 14 figs., table, 20 refs. November.

Introd. "The macroscopic physical behavior of rock under stress is usually explained in terms of the classical linear theory of elasticity. It is generally recognized that stressed rock does not completely satisfy the conditions of isotropy, elasticity, and infinitesimal strain, assumed by the theory but attempts to develop more appropriate theories lead to involved, often intractable mathematical expressions. Provided the limitations are recognized, and the extent to which the rock satisfies the conditions is known, the linear theory of elasticity can be used to advantage in problems of rock mechanics. The so-called 'elastic constants' which define the elastic behavior of a material are not unique properties of a rock but depend significantly on such factors as state of applied stress, stress amplitude, rate and duration of loading, temperature, moisture content of the rock, size and shape of rock specimen, and degree of anisotropy. Any systematic investigation of rock properties should therefore be made under closely controlled conditions. It is then possible to define, approximately, constants valid over a specified range and which may be used to explain rock behaviour.

It is convenient to divide rock mechanics problems into two classes: those involving static or very slowly applied stresses and those involving dynamic or very rapidly applied stresses. Determination of stress conditions around underground openings is an example of the former, and understanding the mechanics of rock fragmentation in blasting is an example of the latter. This paper describes methods used in the rock mechanics laboratory at the School of Mines and Metallurgy, University of Minnesota, to determine the following often-used static and dynamic physical properties of rocks:

1. static compressive strength
2. static tensile strength
3. static and dynamic modulus of elasticity
4. static and dynamic Poisson's ratio.

A description of the testing methods is supplemented by comments on alternative techniques."

Sections included: Specimens. Test equipment. Determination of "static" physical properties. Compressive strength and modulus of elasticity in compression. Apparatus. Total contraction indicator. Poisson's ratio. Specification of compressive strength. Tensile strength and modulus of elasticity in tension. Indirect tensile test (Brazilian method). Determination of the modulus of elasticity and Poisson's ratio from the indirect tensile test. Comparison of the direct and indirect methods. Modulus of rupture and modulus of elasticity in bending. Beam testing apparatus. Dynamic physical properties of rocks. Resonance methods. Pulse techniques. Apparatus. Rheological properties of rocks.

Hoover, Donald B., and Washburn, Jack, 1962, Tensile behavior of lithium fluoride: Jour. Appl. Physics, v. 33, no. 1, p. 11-14, 7 figs., 4 refs.

"Tensile stress strain curves were obtained for single crystals of lithium fluoride. The specimens were elongated at room temperature along a ⟨100⟩ axis. The number of slip band sources was controlled by surface treatment. Both the yield stress and flow stress in the plastic range were found to depend on the number of active slip bands. The shapes of the stress-strain curves were related to the behavior of individual dislocations in the lithium fluoride."

Lombard, David B., 1961, The Hugoniot equation of state of rocks in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 143-152, 9 figs., 2 tables, 15 refs., appendix. November.

Summ. "In considering peaceful applications for nuclear explosions detonated underground, one is concerned with the action of strong shocks which proceed from the center of detonation into the surrounding medium. The propagation of such shocks and their effect on the medium are directly related to the useful purposes to which nuclear explosives can be put. Furthermore, in planning experimental explosions it is highly desirable to predict with good accuracy the effects of the shock. Predictions are based partly on a knowledge of the Hugoniot equation of state.

For these reasons, the equations of state of several common rocks have been measured by Alder's group at Livermore. Plane hydrodynamic shocks were produced by conventional high explosive techniques and transmitted to pellets of the rock by aluminum plates. Shock times-of-arrival at aluminum and rock surfaces, and free-surface velocities were recorded by an argon flash-block technique and a sweep camera. This method has been discussed by various authors. Shock velocity and free-surface velocity are measured in these experiments.

Measurements have been made at pressures ranging from 70 kb to 900 kb. Rock salt, granite, tuff, marble, dolomite, limestone, basalt, and other rocks have been studied; several points on the P-V curve for each have been measured. Particularly interesting data for granite and basalt have been obtained. Further work is in progress.

The desirability of making in situ peak pressure measurements on shocks generated by actual nuclear explosions has led to the development of an instrument which employs pin-contactors to measure shock velocity and free-surface velocity at locations in the rock medium not far from the explosion. The instrument has performed satisfactorily in high explosive tests. It is hoped that shock stresses from below 100 kb to over 1 Mb can be measured in this fashion."

Sections included: Equation of state data. Peak pressure measurements near nuclear explosions. Conclusions.

Plendl. Johannes N., and Gislisse, Peter J., 1962, Hardness of non-metallic solids on an atomic basis: Phys. Rev., v. 125, no. 3, p. 828-832, 3 figs., 3 tables, 5 refs. February 1.

See abstract in "Sources of Information on Rock Physics", December 1961, p. 8.

Popov, V. K., and Dvorkin, Z. P., 1960, Determination of porosity in reservoirs from SP curves: Geologiya Nefti i Gaza USSR, v. 4, no. 5, p. 51-55. Order from ATS, $7.70. Title from Am. Geophys. Union Trans., v. 42, no. 3, p. 319. September 1961.

Vlassov, A. Ya., and Zvegintsev, A. G., 1961 (tr. 1962), The thermoremanent magnetization stability of magnetite against temperature changes and magnetic field reversal: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, (English Transl., January 1962), p. 992-993, fig., 6 refs. October.

"The stability of the full thermoremanent magnetization of magnetite is investigated in a reversed magnetic field as the temperature is increased nearly to the Curie point. The results indicate no reversal of magnetization under these conditions."

Volarovich, M. P., 1961, The investigation of physiomechanical rock properties under high pressures: 9 p. Order from ATS, ATS-01N56R, $13.80. Transl. of Geologiya i Geofizika (USSR), no. 4, p. 13-21, 1961. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 135. February 15, 1962.

Descriptors: *Rock, Pressure, Physical properties, Mechanical properties.

Zhigach, K. F., Adel, I. B., and Gorodnov, V. D., 1961, The effect of temperature on the swelling properties of argillaceous rocks: 7 p. Order from ATS, ATS-80N55R, $9.50. Transl. of Vyssh. Ucheb. Zavedeniy Izv., Neft' i Gaz, v. 4, no. 5, p. 23-29, 1961. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 135. February 15, 1962.

Descriptors: *Rock, Physical properties, Temperature.

Atchison, Thomas C., Duvall, Wilbur I., and Petkof, Benjamin, 1961, Rock breakage in quarry blasting in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 163-169, 6 figs., 3 tables, 8 refs. November.

Abs. "Rock breakage in quarry blasting was studied by taking high-speed motion pictures of the quarry face in front of one shot hole of a production round and measuring the strain produced in the rock at a distance equal to the burden. The initial velocity of the broken rock determined from the high-speed pictures agreed with the velocity calculated from the measured strain, indicating that the initial type of failure was reflection slabbing. Analysis of the pictures also showed that stepwise increases often occurred in the horizontal velocity of the broken rock during the first foot or so of rock movement. These stepwise increases in velocity may be attributed to in-flight impact between rock slabs. High gas pressure in the charge hole when rock is broken by the reflected tensile pulse will accelerate the rock so that it overtakes and hits the next slab in front, causing an increase in velocity. This process will repeat itself until the slab at the face receives an impact that causes the stepwise increase in velocity observed in the high-speed motion pictures. From a consideration of the dynamic tensile strength of the rock and the magnitude of the velocity increase, it appears that in-flight impacts of this type could produce additional rock breakage in quarry blasting."

Sections included: Experimental procedure. Experimental data and analysis. Discussion of results.

----------1962, How rock breaks: Rock Products, v. 65, no. 2, p. 78-81, 118-119, 3 figs., 3 tables. February.

Rocks used in tests: uniform, a fine-grained granite-gneiss; a dolomitic marble; a dense, hard limestone.

Table 1. Physical properties of rocks.
Table 2. Table of quarry blast parameters and observed and calculated velocities.
Table 3. Calculated impact velocity and observed change in fly-rock velocity.

Berry, J. P., 1962, Velocity behavior of a moving crack; Some comments on the paper by Dulaney and Brace: Jour. Appl. Physics, v. 33, no. 1, p. 226-227, figs., 7 refs. January.

Bond, Fred C., 1962, New ideas clarify grinding principles: Chem. Eng., v. 69, no. 3, p. 103-108, 2 figs., 2 tables, 9 refs. February 5.

Sections included: New ideas - the first principle. Comminution's second principle. Work index and third theory. Homogeneous vs. heterogeneous. Work index and the third principle. Determining work index. How product sizes distribute. Correcting for scalped feed. Product analysis by number.

Borecki, Marcin, and Bilinski, Alfred, 1961, Investigations into rock pressure in upper Silesian collieries (Badania Cisnien Gorotworu w Kopalniach Gornoslaskich): 20 p., 6 refs. November. Order from OTS, $0.50. 60-21378. PL-480 Int. Transl. of Przeglad Gorniczy, v. 13, no. 12, p. 594-601, 1957. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 137. February 15, 1962.

Transl. by G. Picek.

Descriptors: *Rock, Pressure, *Mining engineering, *Coal, Poland.

Brace, William F., 1961, Dependence of fracture strength of rocks on grain size in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 99-103, 2 figs., 3 tables, 19 refs. November.

Introd. "The Griffith theory forms the basis of most analyses of brittle fracture. Griffith himself suggested its application to rocks and recently this has been considered in greater detail. According to the Griffith theory macroscopic fractures start at pre-existing flaws, at so-called 'Griffith cracks,' which enlarge and spread under the influence of applied stress. With this model the brittle strength of a material can be calculated for any system of loading if one knows certain material constants and the shape and size of Griffith cracks. This is of obvious interest both in regard to behavior of rocks under engineering loads and in the study of the mechanics of faulting in the earth's crust.

The principal difficulty in applying the Griffith theory to rocks (and indeed to other materials such as glass) is identification of Griffith cracks. One reason is that Griffith cracks may be of microscopic or even of atomic dimensions. However, even if they were visible it would be difficult to follow their growth in an experiment. Cracks once started travel at high velocity; in most cases it would be impossible to stop a crack and observe its path before it reached the surface of the sample. Once a sample is in two pieces, some shearing motion is inevitable and all evidence of the early history is destroyed.

Because of these considerations most tests of Griffith theory for rocks have been indirect; the relative compressive strength of a rock at different pressures is compared with predictions of the theory, or, the observed ratio of compressive and bending strengths is compared with the predicted ratio.

A study of the early stages of fracture of rocks is being carried out by the writer. Several preliminary results are available which may shed light on the nature of Griffith cracks and on the applicability of the Griffith theory to rocks. These results are given below together with relevant aspects of the Griffith theory."

Sections included: Griffith theory. Griffith cracks and grain boundaries. Specific surface energy. Experiments in compression. Indentation hardness and grain size. Discussion and conclusions.

Clark, George B., and Caudle, Rodney D., 1961, Brittle fracture of small short rock beams under central transverse impact loading <u>in</u> Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 137-141, 12 figs., 4 refs. November.

Introd. "The mechanics of fracture of rock and other brittle materials under impact loads for certain types of loading is fairly well established on a macroscopic basis, particularly for slabbing due to reflected waves of normal incidence from free surfaces. The slabbing mechanism is explained largely on the same basis as the reflected wave in a Hopkinson bar. In this work a physical experimental method of investigation was sought which would yield data on rock fracture under conditions different from the Hopkinson geometry.

A method which suggested itself was the utilization of simply supported beams subject to impact loads at midspan. A first series of tests was conducted with small artificial rock beams (hydrostone, a quick-setting mortar cement) of relatively short span. The strain was measured in the bottom fiber at midspan. In these tests it was difficult to separate the effects of the initial response of the beam from the excited natural frequencies. In longer beams, however, it is possible to separate not only the initial pulse but also successive percursors depending upon the characteristic transient response of the beam. Thus, if a beam is long enough and the loading force is localized the initial beam response for the out-traveling wave is independent of the end conditions of the beam. However, once the initial pulse reaches the end of the beam, natural frequencies are excited in accordance with well-known laws of vibration. In some cases it was found that the fracture of beams subjected to central impact occurred on the initial peak strain, while in other cases fracture occurred only when certain frequencies were additive and maximum strain then occurred after the initial pulse."

Sections included: Vibrational theory. Response of rock beams. Method of testing. Effect of repeated drops. Fracture by drop weights. Fractures by blasting caps.

Dulaney, E. N., and Brace, W. F., Jr., 1962, Velocity of a growing crack; Comments on a discussion by J. P. Berry: Jour. Appl. Physics, v. 33, no. 1, p. 227, 7 refs. January.

Hadsell, Frank A., 1961, Scattering of an elastic disturbance by a random medium: Colorado School of Mines, Doctor of Science Thesis, T 913.

Hárosy, T., 1961, Earth pressure acting on and forming in gaps: A Magyar Tudományos Akadémia Műszaki Tudományok Osztályának Közleményei (Hungarian Acad. Sci. Eng. Class Proc.), v. 28, no. 1-4, p. 13-33. Title from Hungarian Tech. Abs., v. 13, no. 4, p. 153.

Kochanowsky, Boris J., and Pinto, Joseph, 1961, Laboratory blasting with models in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 179, table, 2 refs. November.

Lipschutz, Michael E., and Anders, Edward, 1961, On the mechanism of diamond formation: Science, v. 134, no. 3496, p. 2095-2099, 3 figs., 4 tables, 22 refs. December 29.

"Diamonds form by the shock-conversion of graphite, but not by decomposition of metal carbides."

Concl. "In none of our experiments were we able to observe any evidence of diamond formation of growth. It thus appears unlikely that the metastable-phase mechanism was of importance in the formation of the Canyon Diablo diamonds. The discovery of coesite in the sandstone of Meteor Crater and the successful laboratory conversion of graphite to diamond by explosive shock seem to favor the mechanism of a direct conversion of graphite to diamond by the impact shock. Further, we found that the direct solid-state decomposition of cementite at pressures below 45 kilobars and temperatures of 650° to 1000°K does not yield diamond in times of about 1 week."

Livingston, Clifton W., 1961, The natural arch, the fracture pattern, and the sequence of failure in massive rocks surrounding an underground opening in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 197-204, 12 figs., table, 8 refs. November.

Abs. "Throughout geologic time, mountain building has been followed by erosion and subsidence. Rocks of the earth's crust first were loaded, then unloaded. During loading, rocks are deformed by flowage or by fracture. Similarly, during unloading, deformation by elastic rebound within the elastic limit and fracture occurs.

Scientific principles that apply to the behavior of rock subject either to forces of nature or to forces occurring as a result of man-made excavations are stated. Fractures within a rock mass are classified either as occurring during loading or during unloading, and the attitude of the fractures is related to the orientation of the principal strain axes.

The shapes of natural arches produced (1) by static loading and unloading of sandstone as in nature, and (2) as a result of the dynamic loading of a circular opening in sandstone are illustrated using diagrams and photographs. The sequence in which fractures are formed around the opening is described, and the orientation of the fractures is compared with the theoretical orientation of loading and unloading fractures relative to the axes of principal strain."

Sections included: Sequence of events. Mechanics of the loading and unloading process. Orientation and classification of loading and unloading fractures. The natural arch in rocks. The fracture pattern and the sequence of failure.

Longman, I. M., 1962, A Green's function for determining the deformation of the earth under surface mass loads. Part 1. Theory: Jour. Geophys. Research, v. 67, no. 2, p. 845-850, fig., 4 refs. February.

Abs. "A method is given for the determination of the surface deformation of the earth and the perturbation in its superficial gravity field caused by an idealized unit point-mass load placed on the surface. By use of this Green's function the response of an accepted earth model to any superficial mass layer such as the variable ocean tide can readily be calculated. The theory is presented in this paper. Numerical results will be given in a later publication."

Sections included: The equations of equilibrium. The surface distribution of mass. Method of integration. Boundary conditions.

O'Driscoll, E. S., 1962, Fold interference patterns in model experiments: Nature, v. 193, no. 4811, p. 115-117, 5 figs. January 13.

"I have recently undertaken experimental work on the shapes of surfaces resulting from the interference of two intersecting systems of similar folds in an attempt to relate such shapes to geological field observations in South Australia. The experiments have been carried out by means of three-dimensional models in which folds trending in one direction can be superimposed on those trending in another. The mutual interference of the two systems is found to produce a whole assembly of shapes and attitudes familiar to structural geologists......"

Platt, Lucian B., 1962, Fluid pressure in thrust faulting, a corollary: Am. Jour. Sci., v. 260, no. 2, p. 107-114, fig., 35 refs. February.

Abs. "Hubbert and Rubey reviewed occurrences of fluid pressure approaching total overburden pressure in sedimentary rocks, particularly clayey sediments, and suggested that such high fluid pressure is capable of greatly reducing internal friction in the rock and thus facilitating the formation of low-angle thrust faults. Although their principal source of water is within the sediments, connate water, and their principal source of pressure is the weight of overlying sediments, they mention metasomatic and magmatic fluids and the processes that produce these fluids as possible additional sources. Intrusive or remobilized granitic rock is here considered as a source of the water under high pressure because this source has the advantage that it may arrive any time after the stratigraphic seal has been made. Hence thrusting need not occur immediately after a climax of sedimentation. Several possible examples are discussed, and one or two appear reasonable."

Sections included: Suggested corollary. Possible examples. Conclusion.

Poncelet, E. F., 1961, Theoretical aspects of rock behavior under stress in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State

Univ., Mineral Industries Expt. Sta. Bull. 76, p. 65-72, 10 figs., 5 refs. November. Discussion, p. 71.

Author's reply, p. 71-72.

Introd: "When rocks are subjected to stresses the following phenomena can be detected:

1. elastic deformation
2. semipermanent deformation
3. permanent deformation
4. fractures.

To treat the problem from a theoretical angle it is necessary to return to fundamentals and examine critically the nature of stresses as well as that of rocks.

Once these entities are clarified, understanding of the phenomena to be considered is very much simplified. The mechanics of a continuum shed little or no light on the problem."

Sections included: The stress. Application of stress to a particulate body. Application to rocks. Application to explosive charges in bore holes. Recapitulation.

Reynolds, T. D., and Gloyna, E. F., 1960, Reactor fuel waste disposal project, permeability of rock salt and creep of underground salt cavities, final rept.: U. S. Atomic Energy Commission, 121 p., figs. December 30. Order from OTS, TID-12383, $2.50. Sanitary Engineering Research Laboratory, University of Texas, Austin, Texas. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 15. January 1962.

----------1961, Creep measurements in salt in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 11-17, 14 figs., 3 tables, 5 refs. November.

Sections included: Basic considerations. Measurement procedure. Measuring stations in the Grand Saline mine. Measuring stations in the Hutchinson mine. Measurement results and discussions. Grand Saline mine results. Hutchinson mine results. Conclusions.

Sabljak, R., 1957, Analysis of stresses in concrete linings of pressure tunnels (Rechnerische Spannungsermittlung in Beton-Auskleidungen von Druckstollen): 12 p., ref. October. Order from OTS or SLA, $1.60. 59-22390. Trans. no. 343. Transl. of Schweizerische Bauzeitung, v. 73,

no. 14, p. 200-203, 1955. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 141. February 15, 1962.

Transl. by F. Stenger.

Descriptors: *Underground structures, Pressure, Materials, Rock, *Concrete, Reinforcing steel, Steel, Stresses, Mathematical analysis.

Serata, Shosei, 1961, Transition from elastic to plastic states of rocks under triaxial compression in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 73-82, 11 figs., table, 7 refs. November. Discussion, p. 80.

Author's reply, p. 80-82.

Abs. "A theory describing the mechanism of triaxial behavior of rocks in underground formations is developed for the purpose of analyzing underground stress conditions. A phenomenon of an abrupt transition from elastic plastic states of rocks under triaxial compression is anticipated from the theory, which is verified by laboratory experiments simulating conditions in underground formations. Based on the theory and experimental results, a method for determination of the underground stress field is proposed, and the existence of the plastic state and the boundary of transition in underground formations are predicted."

Sections included: Introduction. Transition in Mohr's envelope. Transition in underground stress field. Underground vertical and lateral stresses. Experimental principles. Experimental procedure and correction. Experimental results. Conclusions.

Serdengecti, S., and Boozer, G. D., 1961, The effects of strain rate and temperature on the behavior of rocks subjected to triaxial compression in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 83-97, 22 figs., 11 refs. November.

Abs. "This paper presents the results of dynamic triaxial compression tests performed to determine the strength characteristics of Berea sandstone, Solenhofen limestone, and Pala gabbro rocks subjected to controlled stress, strain rate, and temperature conditions. Control of the stress was established by varying liquid pressures within and around a rubber jacketed cylindrical rock specimen. The pressure liquid external to the rubber jacket corresponded to the overburden pressure on natural rocks buried at depth. The liquid pressure within the rubber jacket corresponded to the interstitial pressure of formation waters within natural rocks. The state of stress of a rock is determined by the particular values of these two pressures. The liquid pressures were varied throughout the range from atmospheric to 20,000 psi. The temperatures of the rock specimens were varied in the range from room temperature to 300 F, and the axial strain rates were varied from 10^{-3} to 100 per cent per second. The data obtained show that, for a given state of stress and temperature, the axial compressive stress required to fracture the rock specimen increases as the strain rate is increased, and the type of failure observed changes from ductile to brittle. Furthermore, within the above specified ranges of temperature and strain rates, it appears that for a given state of stress the effects of changing the strain rate may be obtained by merely changing the temperature of the test.

A mechanical equation of state is proposed for Solenhofen limestone that predicts compressive strength for given stress, strain rate, and temperature conditions."

Sections included: Apparatus and procedure. Experimental results. Berea sandstone. Solenhofen limestone. Pala gabbro. Equivalence of strain rate and temperature effects. A mechanical equation of state for Solenhofen limestone. General remarks concerning the results. Concluding remarks.

Short, Nicholas M., 1961, Excavation of contained TNT explosions in tuff in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 171-178, 8 figs., 2 tables, 4 refs. November.

Sections included: Explosion conditions. Method of investigation. Results. Interpretation and conclusions.

Shreiner, L. A., and Pavalova, N. N., 1958, Experimental data on the fatigue failure of rock formations (in Russian): Akad. Nauk SSSR In-Ta Nefti Trudy, no. 11, p. 46-52. See also, Ref. Zh. Mekh., no. 7, Rev. 8081, 1959. Title and review from Appl. Mech. Rev., v. 14, no. 12, p. 956. December 1961.

Rev. "An investigation of the relationship between the speed of drilling in rock formations and the load on the drilling tool; a distinction is made between the regions of superficial, fatigue, and 'normal' failure of the rock. The two first forms of failure take place at stress values below the yield strength. A comparison is made between the fatigue failure and the fatigue limit of metals and rocks. For both rocks and metals, a characteristic is the reduction in the fatigue limit with increasing inhomogeneity of the structure; the fatigue limit for these materials also depends on the conditions of the stress state, the medium, and the absolute dimensions of the samples. The number of load cycles N, required for the failure of rock formations at stress values approaching the yield limit, is some 5-6 orders of magnitude below the value for metals, the value of N being lower for brittle rocks of low plasticity than for rocks of higher plasticity.

For the purpose of investigating the mechanism of fatigue failure in rocks, as well as determining the fatigue limit and the value of N, tests were made on different rock formations under repeated, dynamic penetration (using a shore scleroscope). The instant of failure was determined from the decrease in the value of the recoil of the striker. The experimental equipment is described and the results recapitulated. From these data, an empirical formula has been derived determining the limiting value of the specific impact energy, not causing failure of the rock at $N = \infty$ (fatigue limit). The relationship of the fatigue limit to the specific energy of destruction at one flow (i.e., to the yield strength) is much lower than in the case of metals, being about 1:21 to 1:29 for the materials tested (dolomite, marble, and Solenhofen limestone)." - R. I. Kripyakevich.

Singh, Mandan M., and Hartman, Howard L., 1961, Hypothesis for the mechanism of rock failure under impact in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 221-228, 10 figs., 24 refs. November.

Introd. "Little is known regarding the mechanism of rock fracture, especially under dynamic loading, in spite of the extensive exploitation of impact to achieve fragmentation, penetration, and comminution in the mineral and construction industries. Impact loading causes a stress pulse to propagate through the medium, and if the amplitude of the pulse is sufficiently large, it may produce fractures.

Cracks caused by stress pulses differ from those obtained under static loading conditions for several reasons:

1. Crack propagation velocity is generally far lower than the velocity of the pulse, and hence cracks that may be formed do not have time to grow before the pulse has traveled through and the stress removed.

2. A stress pulse affects only a small portion of the solid at a time, and fractures may develop in a part of it without being affected by what is occurring in other parts.

3. A compression pulse may be reflected from a free surface to give a tension pulse, and vice-versa. When the incident pulse meets the boundary obliquely, both dilatational and distortional pulses are produced. Interference of such pulses may result in very complex stress distributions in the body, and the superposition of several such reflected pulses may be capable of producing fractures.

4. Under dynamic loads, many materials which behave in a ductile manner under static loading are known to assume brittle characteristics.

Dynamic loads may be applied either by the detonation of an explosive or striking of an impact blow. Several investigations have been made with materials under explosive attack, but little work has been conducted on the effect of a chisel-shaped tool on a rock mass. The latter process, however, assumes special importance from the viewpoint of rock penetration and drilling, and consequently this study was primarily directed towards this phase."

Sections included: Importance of impact in drilling. Previous studies. Early work. DRI theory. Experimental procedure and results. Theoretical analysis of wave action. Proposal of hypothesis of failure. Limitations of the hypothesis.

Stokes, R. J., Johnston, T. L., and Li, C. H., 1962, Kinking and the fracture of ionic solids: Jour. Appl. Physics, v. 37, no. 1, p. 62, 6 figs., 17 refs.

Abs. "A single crystal undergoing plastic bending develops constraints due to the gradient in lateral contraction across the beam. These constraints result in lateral stresses which may be relieved by the process of anticlastic kinking. Anticlastic kink boundaries in rock salt structure solids consist of arrays of $\{121\}$ $\langle 110 \rangle$ edge dislocations formed by the interaction of two systems of $\{110\}$ $\langle 110 \rangle$ glide dislocations, one system being responsible for slip in the main part of the crystal beam, the other confined to its corner. Temperature affects the structure of kink boundaries and their subsequent rôle in initiating fracture.

I. At high temperatures ($\sim$ 0.3 Tm) the resultant edge dislocations in the boundary can move over their $\{121\}$ slip planes and the kinks become sharp. The resultant dislocations are ineffective barriers to slip and crystals are ductile.

II. At low temperatures ($\sim$ 0.1-0.2 Tm), the resultant edge dislocations are immobile and the kinks consist of a diffuse array. The resultant dislocations provide strong barriers to slip cracks nucleate at the kink boundary.

III. At any low temperatures (~ 0.1 Tm) fracture occurs before the second set of {110} ⟨110⟩ glide dislocations have been activated to generate anticlastic kinks. Relaxation of the lateral stress results in a complex fracture."

Sections included: Experimental procedure. Anticlastic kinking. Fracture behavior of sodium chloride bent at liquid-nitrogen temperature. Kinking and nitration of fracture in ionic solids. Summary and conclusions.

Whitten, Charles A., 1961, Measurement of small movements in the earth's crust: Acad. Sci. Fennicae Annales, Ser. A, III. Geologica-Geographica, p. 315-320, 2 figs., 10 refs.

Discussion of the measurement of small movements in the earth's crust in California.

LOADING

Appl, F. C., and Gatley, W. S., 1961, Rate of loading effects in chisel impact in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 229-235, 10 figs., 2 tables, 4 refs., appendix. November.

Abs. "This paper presents a combined analytical and experimental study of chisel penetration vs. time during chisel impact on rock, a problem of fundamental importance in improving the performance or roller cone bits or percussive-type drilling apparatus.

For an arbitrary, given load (force between chisel and rock) vs. time, the problem of determining the penetration (displacement) vs. time of the chisel is formidable. This is so because the rock is a nonlinear system with distributed mass and distributed damping (friction, dissipation of energy due to rupture, etc.). Since the literature does not contain adaptable solutions, the rock behavior to impact was simulated approximately by an 'equivalent' lumped system; that is an 'equivalent' mass, spring, dashpot system.

With this assumption an analytical solution was found for chisel penetration vs. time due to a sinusoidal load between chisel and rock. From this solution were found curves, in terms of dimensionless variables, for the maximum depth of penetration vs. the frequency of the sinusoidal loading, and for the energy transfer vs. frequency. The results of this analysis were used to predict the penetration rate of rotary rock bits vs. rotary speed. The curve indicated that an optimum speed exists.

To verify the analysis, an experimental apparatus was constructed and used to apply a sinusoidal pulse to a chisel penetrating a rock specimen under atmospheric conditions. Strain gages were mounted on the chisel shank and a velocity transducer was mounted between the chisel and rock surface. The velocity was integrated electrically and picked up simultaneously with the strain gage signal on an oscilloscope. Permanent records were made photographically to provide simultaneous records of force vs. time and penetration vs. time.

In comparing the experimental results for limestone and dolomite with the theoretical results, good agreement was found in the frequency range of the experiments. Unfortunately, the small inertia effect (peak penetration) indicated by the theory occurs at a frequency much higher than could be obtained experimentally with the apparatus constructed. A 'rate of loading' effect is thus indicated theoretically, but has not yet been verified experimentally."

Sections included: Theoretical analysis. Prediction of rotary rock bit performance. Experimental apparatus and test procedures. Experimental results. Comparison of theory and experiment. Conclusions.

Baum, F. A., 1959, Physics of an explosion: Moscow, Fizika Vzryva, mono., 800 p. Title from Tech. Transl., v. 7, no. 3, p. B-5. February 15, 1962. Transl. in process.

Mindeli, E. O., 1960, Calculation of a specific explosive charge (Required in blasting) (Raschot Udol'nogo Zaryada VV): S.M.R.E. Trans. no. 4426; (DSIR LLU) M.3063, 6 p., ref. November. Order from OTS or SLA, $1.10. 61-27594. Transl. of Shakhtnoe Stroitel'stvo (USSR), no. 11, p. 16-17, 1959. Title, abstract and descriptors from Tech. Transl., v. 7, no. 2, p. 80. January 30, 1962.

Transl. by L. Moyor.

"Experimental investigations and data obtained from present-day practice established that the specific explosive charge depends on the cross-sectional area of the mine working, the depth of the shot-hole, the diameter of the explosive cartridges, the physical-mechanical properties of the intersected strata, the number of shotholes, the coefficient of the efficiency of the shothole, the density of the charge and the blasting power of the explosive."

Descriptors: *Explosives, *Shaped charges, *Mining engineering, Blast, Determination, Demolition.

Selig, E. T., and McKee, K. E., 1961, Static and dynamic behavior of small footings: Am. Soc. Civil Engineers Proc. Jour. Soil Mechanics and Foundations Div., v. 87, no. SM6, pt. 1, p. 29-47, 23 figs., 2 tables, 5 refs. December.

Synop. "A number of small footings resting on sand have been subjected to both static and dynamic loads. Load-displacement characteristics have been determined experimentally for a series of these footings subjected to static loading. The results 82 experiments are correlated for square, circular, and rectangular footings. The load-displacement curves and typical sand failure patterns are included and examined, and the resulting bearing capacities are compared with the Terzaghi equations. The dynamic loads were created by the impact of a falling weight. The energy of impact is correlated with total footing settlement for 57 tests. The behavior under these types of static and dynamic load is compared with special emphasis given to the nature of the soil distortion. The difference in mode of failure of the sand for these two situations is clearly illustrated by photographs taken of both the surface of the soil and of a vertical plane through the soil."

Sections included: Experimental conditions. Three-dimensional experiments. Three-dimensional static results. Two-dimensional static results. Three-dimensional dynamic results. Two-dimensional dynamic results. Bearing capacities compared with theory. Summary and conclusions.

ENGINEERING APPLICATIONS

Adler, Lawrence, 1961, Rib control of bedded roof stresses in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 205-209, 9 figs., table, 9 refs. November.

Introd. "The analysis of stresses surrounding an opening in bedded rock relies primarily on beam theory with its simplifying assumptions, as given in Table 1. While not entirely necessary, these assumptions permit us to deal with a sufficiently simple structure so as to emphasize our departure from conventional analysis. The total structure appears in Fig. 1; the simplified structure consists of the main roof only loaded by its own weight, and the rib.

The usual method of stress analysis detaches the beam just within the opening at the rib, and replaces the actual stresses with a statically equivalent shear (Q_O) and moment (M_O) system, where the shear due to static equilibrium equals one-half the beam weight. However, the value of the end moment, being statically indeterminate, is assumed to range between restraints which are fixed and free, a 40-per cent variation. The first purpose of this paper will be to analytically reduce this excessive spread. In addition, an optimum value for the end moment exists, as shown in Fig. 2, which reduces the maximum moment by about 30 per cent when compared to free or fixed ends. A second goal will be to recommend means of control so as to achieve this desired condition.

A third purpose which becomes apparent almost in passing, but which is of major significance, is the determination of the rib or abutment loads which are otherwise unknown. This problem has particular bearing on the successful operation of longwall caving."

Sections included: Analysis. Conclusion.

Anonymous, 1961, Selections on hydrogeology and engineering geology, Communist China: Joint Pub. Research Services 4909, 24 p., figs., refs. August 23. Order from OTS, Xerox, $2.60. 61-28045. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 54. January 1962.

----------1961, Selections on hydrogeology and engineering geology, Communist China: Joint Pub. Research Services 4951, 50 p., figs. September 6. Order from OTS, Xerox, $4.60. 61-28575. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 54. January 1962.

Anonymous, 1961, Selections on hydrogeology and engineering geology, Communist China: Joint Pub. Research Services 4993, 20 p., figs., bibliog. September 19. Order from OTS, Xerox, $2.60. 61-28572. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 55. January 1962.

----------1961, Translations on hydrogeology and engineering geology, Communist China: Joint Pub. Research Services 10303, 35 p., figs. September 29. Order from OTS, Xerox, $3.60. 61-28861. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 64. January 1962.

----------1961, Translations on hydrogeology and engineering geology, Communist China: Joint Pub. Research Services 10633, 33 p., figs., refs. October 18. Order from OTS, Xerox, $3.60. 62-13020. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 69. January 1962.

Ballakh, I. Ya., 1961, Experiment with seismic exploration in the direct search for oil and gas deposits: 4 p. Order from ATS, ATS-36N55R, $6.50. Transl. of Akad. Nauk SSSR Doklady, v. 137, no. 5, p. 1174-1176, 1961. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 133. February 15, 1962.

Descriptors: *Geophysical prospecting, *Petroleum, *Natural gas, Deposits, *Seismic waves.

Born, W. T., 1962, Technical limitations of present geophysical tools: Geophysics, v. 27, no. 1, p. 133-137, fig. February.

"......Limitations of geophysical methods

1. The indirect approach
2. Instrumental
3. Range of investigation
4. Noise
5. Limited resolving power
6. Ignorance......"

Böszörményi, B., Szepesi, P., and Szőnyey, B., 1961, Ploughing tests in mineral mines: Bányászati Lapok (Hungarian Jour. Mining), v. 94, no. 4, p. 245-247. Title from Hungarian Tech. Abs., v. 13, no. 4, p. 151.

Boyum, Burton H., 1961, Subsidence case histories in Michigan mines in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 19-57, 33 figs., 4 tables, 17 refs. November.

Summ. and Concl. "This report covers the cumulative studies on mine subsidence in Michigan underground iron mines, with particular emphasis on the investigations by The Cleveland-Cliffs Iron Company. Most of the information and effort have been related to the Marquette Iron Range, the oldest in the Lake Superior region.

A historical summary is presented with a brief description of the geology of the Marquette Iron Range. Sketches of some early subsidence case histories are related.

This report describes in detail the methods employed in recent years, (1945-1960), in collaboration with the U. S. Bureau of Mines. Cleveland-Cliffs' program was directed towards detecting the possible subsidence from underground workings by the use of instrumented diamond drill holes. For the most part, these holes were specifically drilled for this purpose. Application of the microseismic method of predicting rock failure is discussed in a variety of circumstances. Also described is the use of surface subsidence pin surveys, interval velocity studies, and reflection seismic surveys. Detailed tests on complete physical properties of selected earth materials are discussed with reference to geologic structures.

The company has considered a variety of techniques in its effort to predict the progress of subsidence. These studies have shown the complexity of the various factors and indicated the difficulties in predicting the place and time of mine subsidence. The cost of the use of these techniques is a major factor to consider in future applications.

In order to apply any of the techniques described in the report, it is necessary to obtain considerable basic data relating to thephysical properties of the various rock types and the general geologic structures. The greatest single factor in mine subsidence is the relationship of the geologic features to the mining methods in underground mining."

Sections included: Geology of the Marquette Iron Range. Early Michigan subsidence studies. Briar Hill Mine, Old Menominee Range. Athens Mine, Negaunee. U. S. Bureau of Mines study. Blueberry Mine. Cliffs Shaft Mine. Later methods and techniques. Microseismic observations (General system, Pillar studies, Surface and long underground drill hole application, Triangulation). Drill holes (Microseismic geophones, Drill hole caliper, Drill hole camera, Oilfield electrical logging, Radioactivity logging, Water level and current flow, Velocity measurements, Bore hole television, Location and cost of drill holes). Surface surveys. Determination of physical properties of the various earth materials. Ground water studies. Velocity studies.

Reflection seismic surveys. Graphical presentation. Photographic studies. Gravity surveys. Strain gage measurements. Recent case histories. Cliffs-Shaft mine. Cambria Jackson mine. Athens mine. Mather mine.

Danielson, W. E., 1961, Project Vela Uniform: Bell Telephone Labs., Whippany, N. J., Quarterly rept. no. 2, 1 June-31 Aug 61, Contract NObsr-85206, ARPA Order no. 192-61, 5 p. August 31. Order from OTS, AD-266 256, $1.10. Unclassified rept. Title, abstract and descriptors from U. S. Govt. Research Repts., v. 37, no. 3, p. 149. February 5, 1962.

"Instrumentation of a seismic research facility is described and preliminary efforts at interpreting spectrograms to assess their value in distinguishing manmade from natural seismic phenomena are presented. During this period, construction of a seismometer vault was started, a breadboard spectrum analysis and writeout equipment was completed, and a collection of taped seismic events was readied for analysis and interpretation." - Author.

Descriptors: (Research program administration, Earthquakes, Instrumentation, *Operations research.) (Earthquakes, Nuclear explosions, *Seismic waves.) (Analysis, Magnetic tape, Radiofrequency spectrum analyzers, Terrestrial magnetism.)

Deere, Don V., 1961, Subsidence due to mining - A case history from the Gulf Coast region of Texas in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 59-64, 7 figs., 2 refs. November.

Sections included: Field measurements. Measurements of vertical movement (Grid system, Base lines). Measurements of horizontal movements (Base lines, Triangulation monuments, Slope indicator installations). Results of field observations. Subsidence (Magnitude of subsidence, Rate of subsidence). Horizontal movements (Horizontal strains, Horizontal vectors of movement, Horizontal displacements with depth). Critical angles.

Denisov, N. Ya., 1957, Engineering geology and hydrogeology, selected sections: Inzhenernya Geologiya i Gidrogeologiya, Moscow, p. 137-143, 210-276, 287-301. Order from OTS, $1.00. Title from Am. Geophys. Union Trans., v. 42, no. 3, p. 317. September 1961.

Dobos, I., 1961, Geological results of electrical logging in prospecting bores in the Dorog, Tatábanya and Oroszlány coal basins carried out from 1954 to 1958: Hidrólogiai

Közlöny (Jour. Hydrology), v. 41, no. 3, p. 311-316. Title from Hungarian Tech. Abs., v. 13, no. 4, p. 151.

Engineering News-Record, 1962, Reader comment on "Foundation Technology Lags": Eng. News-Rec., v. 168, no. 9, p. 6. March 1.

Original article appeared in Engineering News-Record, January 11, 1962, p. 76.

Comments from James J. Schnabel (President, Foundation Test Service, Washington, D. C.); G. F. Hermann (George Hermann & Sons Drilling Contractors, Erie, Pa.); K. S. Kemp (Plant Engineer, IBM Corporation, Endicott, N. Y.).

See also Terzaghi, K., Eng. News-Rec., v. 168, no. 7, p. 58-59. February 15.

Evison, F. F., 1956, A proposed method of locating faults ahead of mine workings in Mining and Quarrying Conf. Proc., Otago Univ. (New Zealand) School of Mines and Metallurgy, August 14-16, 1956. Volume 3. Coal Mining: Paper no. 93, 4 p. Discussion, p. 4.

Concl. "Guided waves such as the Love wave observed at Mangapehi may provide a means of locating faults ahead of the face. Should this proposal be considered to offer something of practical value it should be further tested by experiments on a known fault."

Sections included: Difficulties with seismic sounding. Guided seismic waves. Application of the Love wave. Conclusions.

-----------1956, The convergence recorder as an indicator of heave and crush in Mining and Quarrying Conf. Proc., Otago Univ. (New Zealand) School of Mines and Metallurgy, August 14-16, 1956. Volume 3. Coal Mining: Paper no. 91, 11 p., 4 figs. Discussion, p. 5-11.

Introd. "Convergence recorders were introduced in New Zealand in 1953 and have since been used for investigations in the Dobson, Wallsend, Paparoa, Wairaki No. 3 and Mangapehi State Coal Mines. The investigations have been a joint concern of the Mines Department and the Department of Scientific and Industrial Research......

Many thousands of daily convergence values have now been collected. It is essential to have such large numbers of observations before conclusions with any claim to generality can be arrived at, because conditions in the mines are so complex and variable......

......The present paper deals primarily with the convergence produced by deformation of the floor strata and pillar coal respectively."

Sections included: Types of convergence. Observations of heave and crush. The threshold of crushing. The pressure arch. Conclusions.

Fitzgerald, Martinez, and Staadt, 1961(?), Formation fracturing in Petroleum production handbook: McGraw-Hill Book Co., Inc., New York, 2 v., 1,872 p. Title and review in Jour. Petroleum Technology, v. 14, no. 1, p. 58. January 1962. T. C. Frick, editor.

Frick, T. C., editor, 1961(?), Petroleum production handbook: McGraw-Hill Book Co., Inc., New York, 2 v., 1,872 p. Title and review in Jour. Petroleum Technology, v. 14, no. 1, p. 58. January 1962.

"This comprehensive work is divided into three sections (two separate volumes) covering mathematics, production equipment and reservoir engineering......A total of 986 charts, graphs, tables and illustrations are included......"

There are 71 authors listed, included here:

Amyx, J. W., and Bass, Daniel W., Jr.
Fitzgerald, Martinez, and Staadt
Koepf, E. H.

Koepf, E. H., 1961 (?), Typical core analysis of different formations in Petroleum production handbook: McGraw-Hill Book Co., Inc., New York, 2 v., 1,872 p. Title and review in Jour. Petroleum Technology, v. 14, no. 1, p. 58. January 1962. T. C. Frick, editor.

Mining Journal, 1962, Wagon drilling in hard rock: Mining Jour. (London), v. 258, no. 6598, p. 119. February 2.

"In current operations it is possible to sink economically large diameter blast holes to considerable depths in very hard rock. DEMAG have participated in this development with their BWH large diameter hole wagon drill, and during the last three years one such wagon drill has drilled more than 15,000 metres of blast holes at 75 mm. dia. in the basalt quarry of Messrs. Johannes Nickel oHG at Ober-Widdersheim, West Germany. The article is condensed from a detailed report of these operations that appeared in Demag News No. 160."

"The rock......is a coarse grained, medium-acid basalt separated into thick, vertical columns 80-120 cm. in dia. Compressive strength is about 4,000 kg./cm......"

Reilly, W. I., 1956, Influence of roof strata on convergence in coal mines in Mining and Quarrying Conf. Proc., Otago Univ. (New Zealand) School of Mines and Metallurgy, August 14-16, 1956. Volume 3. Coal Mining: Paper no. 92, 7 p., 6 figs.

Introd. "......This paper deals with the elastic effects of the roof, including its role in distributing pressure over the mine workings, and the dislocations it suffers in the neighbourhood of openings......"

Sections included: Distribution of convergence near working places. Normal distribution. Anomalous distributions. Dislocations of roof strata. Sag of roof strata over openings. Convergence and fractures in the lower roof strata. Convergence preceding a fall of roof. Convergence and 'bumps'. Conclusions.

Schwartz, Bertrand, 1961, Movements of the roof and floor in roadways in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 1-10, 13 figs. November.

Sections included: Roadways uninfluenced by longwall faces. Representation. Consequences (The nature of the rock, The influence of mining-operation factors). Roadways influenced by their longwall faces. Representation. Consequences (Calculation of the supports, Calculation of roadway safety pillars, Nature of the rock, Study of the influence of the support density, Influence of the rate of advance of the face, Anomalies due to safety pillars). Conclusions.

Spencer-Compton, L. C., 1961, Big blast on the Golden Mile: Mining Mag. (London), v. 105, no. 6, p. 340-341, 2 figs. December.

Brown Hill mine of Gold Mines of Kalgoorlie (Aust.), Ltd. May 6, 1961, large controlled underground blast, 200 cases of explosive, 1 1/8 in. diameter (27,000 plugs 75% gelatine dynamite, 27 rolls Cordtex). Twenty-six thousand ft. of holes drilled and 75% loaded with explosives. Total of 45,000 tons of ore broken from 60 ft. below the surface to depth of 180 ft. Crater 60 ft. in diameter grew to 80 ft.

Symposium on Rock Mechanics, 4th, Pennsylvania State University, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, 251 p., figs., tables, refs. Howard L. Hartman, editor.

Sponsored by the mining departments of Colorado School of Mines, University of Minnesota, University of Missouri

School of Mines and Metallurgy, and The Pennsylvania State University. Supported by the National Science Foundation.

The symposium was divided into the following technical sessions:

Strata Movement from Underground Openings

Boyum, Burton H.
Deere, Don V.
Reynolds, Tom D., and Gloyna, Earnest F.
Schwartz, Bertrand

Behavior of Rock Under Static Loading

Brace, William F.
Fairhurst, C.
Poncelet, E. F.
Serata, Shosei
Serdengecti, S., and Boozer, G. D.

Behavior of Rocks Under Dynamic Loading

Atchison, Thomas C., Duvall, Wilbur I., and Petkof, Benjamin
Clark, George B., and Caudle, Rodney D.
Isaacson, E. de St. Q.
Kochanowsky, Boris J., and Pinto, Joseph
Lombard, David B.
Rinehart, John S., Fortin, Jean-Pierre, and Burgin, Lorraine
Short, Nicholas M.

Stress Measurement and Ground Control

Adler, Lawrence
Livingston, Clifton W.
Panek, Louis A.
Reed, John J., and Mann, C. David
Wilson, A. H.

Dynamic Loading in Rock Penetration

Appl, F. C., and Gatley, W. S.
Gray, K. E., and Gatlin, Carl
Singh, Madan M., and Hartman, Howard L.

Buzz Session; Summaries page 243-251. Leaders were:

Duvall, Wilbur I., and Pinto, Joseph
Morrison, R. G. K., and Jackson, Ivan
Robinson, Leon H., Jr., and Tandanand, Sathit
Stefanko, Robert, and Falkie, Thomas V.

Terzaghi, Karl, 1961, Engineering on the job and in the classroom: Boston Soc. Civil Engineers Jour., v. 48, no. 2, p. 97-109. April.

Discussion, Boston Soc. Civil Engineers Jour., v. 49, no. 1, January 1962.

Discussed by:

Banks, Harvey O., and James, Laurence B., p. 44-47.
Campbell, Ian, p. 48-50.
Cleaves, Arthur B., p. 51-55, 3 refs.
Sections included: Geological engineer and the engineering geologist. Geological disciplines in earthwork engineering. Role in rock engineering. Conclusion.
Deere, Don V., p. 56-60.
Dolmage, Victor, p. 61-63.
Sections included: Geological training. The civil engineer. Geological training for the engineer. Engineering geology.
Dunn, C. P., p. 66-67.
Kolb, Charles R., p. 68-72, fig.
Peck, Ralph B., p. 73-78.
Ripley, Charles F., p. 79-83, 4 refs.
West, P. J., p. 84-86.

Closure of discussion of paper entitled "Engineering on the Job and in the Classroom", by Karl Terzaghi, Boston Soc. Civil Engineers Jour., v. 49, no. 1, p. 87-95, 2 refs. January 1962.

"The danger of misusing rock mechanics is aggrevated by the following fact. The significant physical properties of most rock formations which can conceivably be the cause of engineering difficulties have a striking resemblance to those of sedimentary deposits with an erratic pattern of stratification. Therefore they cannot be determined reliably in advance of construction by any practicable means. Some of the engineering consequences of this condition will be described by the writer in a paper 'Measurement of Rock Stresses' to be published in 1962 in Geótechnique......"

Sections included: Engineering geology in the curriculae for civil engineers. Function of the geologist in earthwork engineering. Rock mechanics. Mental process involved in subsurface engineering. Engineering geology as a profession.

----------1962, Does foundation technology really lag?: Eng. News-Rec., v. 168, no. 7, p. 58-59, 2 figs. February 15.

Discussion of the rock foundation failure of the Malpasset

Dam and Wheeler Lock, the foundation tests and the responsibility of the engineer to "pay more attention to the inevitable uncertainties attached to the results of subsurface exploration of any kind."

Titkov, N. I., and others, 1959 (tr. 1961), Electrochemical induration of weak rocks: New York, Consultants Bureau Enterprises, Inc., 52 p., durable paper covers $12.50.

"This significant book presents scientific bases for and results of investigations and field testing of a new method of strengthening weak rocks in drill holes using electrochemical principles. The authors describe how rocks may be cemented or firmed by electrochemical means, thus saving the time and expense of casing. This method has excellent prospects for widespread application in the nonmetallic consolidation of the side walls of oil and gas wells, during the sinking of shafts and ventilation shafts in the coal and ore industries, in carrying out various hydro-technical construction and other development work, in irrigation canals, in the construction of railway embankments, highway cuts and roadbeds, and in the preparation of new forms of construction materials."

Voress, Hugh E., compiler, 1961, Peaceful uses of nuclear explosions, literature search: U. S. Atomic Energy Commission, 18 p. October. Order from OTS, TID-3522, $0.50. 5th rev. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 15. January 1962.

Young, Francis M., and McCaslin, John G., 1962, Breaking rocks with electricity: Mining World, v. 24, no. 2, p. 23, 35, 4 figs., 2 refs. February.

Discussion of tests conducted by Academy of Sciences USSR, Institute of Mining Laboratory for Application of Electrical Technology in Mining and the Montana School of Mines tests for Anaconda Company.

"......Present knowledge in this field is limited. Consequently, among the studies that need to be undertaken are 1. the relationships between working voltage, power input, time, and frequency; 2. the limitations on the size of rock that can be broken efficiently; 3. the effect of electrode placement and spacing; 4. the effect of mineralogy (rock type) and structure upon fracturing and fracture patterns; and 5. a thorough investigation into the physical parameters involved: such as dielectric strength, dissipation factor, temperature coefficient of resistance, etc......"

Bath, Markus, 1961, Seismic investigation of crustal structure: Uppsala Univ. (Sweden), Annual tech. rept. no. 1, 1 Nov 60-31 Oct 61, Contract DA 91-591-EUC-1637, ARPA Order no. 165-61, 25 p. November 3. Order from OTS, AD-266 199, $2.60. Unclassified rept. Title, abstract and descriptors from U. S. Govt. Research Repts., v. 37, no. 3, p. 6. February 5, 1962.

"The structural relation between Iceland and the surrounding ocean, especially the Mid-Atlantic Ridge, was investigated by means of group-velocity dispersion curves for Love and Rayleigh waves from earthquakes in the region." - Author.

Descriptors: (*Earth, Structures, Velocity, Seismic waves in Iceland, Sweden, Denmark, Finland.) (Geophysics, Measurement, *Geology, Rock, Granite, Sedimentation.) (Earthquakes, Wave transmission, Refraction, Explosions.)

Bennett, A. D., 1962, Study of multiple reflections using a one-dimensional seismic model: Geophysics, v. 27, no. 1, p. 61-72, 9 figs., table, 14 refs. February.

"A one-dimensional seismic model consisting of a multisection metal rod was used in a study of multiple reflections. The model was designed from velocity data provided by an acoustic velocity log. Reflecting interfaces were introduced into the model by changing the rod diameter. An acoustic pulse simulating a shot was applied near the top of the model by a magnetostrictive transducer. Reflections were detected by a crystal receiver placed at the top of the model. Means were devised to achieve an acceptable correspondence in character between a field seismic record obtained at a well site and a synthetic record produced by the model based on acoustic velocities in the well. Model techniques were worked out to separate and identify primary and multiple reflections as an aid in the interpretation of field seismic records."

Sections included: Introduction. Multiple reflections. One-dimensional model. Design of the model. Operation of model. Study of field site. Duplication of seismic record. Primaries and multiples on model record. Application to interpretation of seismic records. Conclusions.

Bessonova, E. N., and others, tr. 1961, Investigation of the mechanism of earthquakes: Soviet Research in Geophysics, v. 4. New York, Consultants Bureau Enterprises, Inc., 201 p. $7.50.

(continued on next page).

Transl. from Acad. Sci. USSR Geophys. Inst. Trans. no. 40.

"The results of work conducted by the Geophysical Institute of the Academy of Sciences, USSR, since 1948 on the investigation of fault plane displacements are documented in this volume. During this period a method was evolved which makes it possible to determine the mechanical type of fractures at the focus, the dip and strike of the fault plane, and the direction of the displacement and order of the relative intensity of the first shock. Many of the methodological conclusions and results of interpretations are being published for the first time.

The present work is dedicated to the systematic presentation of the current state of the investigations under study. The first part contains the theoretical basis for and a condensed description of the methodology which, with the indicated references, may be used as a guide for the research seismologist. The second part presents summary data regarding displacements near earthquake centers of the various seismic areas of the USSR."

Contents: Part I. Methodology of interpretation. Basic results of previous work. Theoretical assumptions. The method of interpretation. Part II. Displacements at earthquake foci (principally active seismic zones in the USSR and adjacent countries). Statement of the problem and review of previous research. Results of study of separate seismic regions. List of earthquakes processed. Appendices.

Gamburtsev, G. A., 1952 (tr. 1959-1960), Seismic probing of the earth's crust: Geophys. Soc. Tulsa Proc., v. 6, p. 25-28, 7 refs.

Transl. of Doklady Akad. Nauk SSSR, v. 87, no. 6. December 1952.

Hammond, J. W., 1962, Ghost elimination from reflection records: Geophysics, v. 27, no. 1, p. 48-60, 12 figs., ref. February.

"A method is described for the elimination of ghost energy from reflection records. Two or more shots at different depths are recroded on magnetic tapes. The magnetic tapes are then composited in groups of two or more. The formula is derived for the calculations of shot depth separation and the relative displacements of the magnetic tapes on replay. The application of the method to an everyday field technique is illustrated with examples."

Hyun, Byung Koo, 1961, Seismic energy absorption analysis by relaxation time: Colorado School of Mines Doctor of Science Thesis, T 933.

Keylis-Borok, V. I., and Pavlova, G. I., 1960, The generalization of data on the mechanism of earthquakes: Akad. Nauk SSSR Institut Fiziki Zemli. Trudy, no. 11 (178), p. 121-132. Order from OTS, $0.50. Title from Am. Geophys. Union Trans., v. 42, no. 3, p. 317. September 1961.

Levin, Franklyn K., 1962, The seismic properties of Lake Maracaibo: Geophysics, v. 27, no. 1, p. 35-47, 15 figs., 13 refs. February.

"The seismic properties of Lake Maracaibo were investigated in an extensive experimental program. The controlling factor was found to be extremely low mud velocities produced by free gas in the bottom mud. The most important seismic phenomenon was singing, and its characteristics were investigated in detail. Deviations from the behavior expected from a simple theory were found. A strong, low-frequency mud wave was present. Where the mud was not too thick, normal dispersion occurred."

Sections included: Singing seismograms. Mud waves. Normal dispersion.

Pasechnik, I. P., 1961, Seismic method of detecting and identifying nuclear explosions, USSR: Joint Pub. Research Services 10888, 17 p., figs., bibliog. November 8. Order from OTS, $0.50. 61-31681. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 76. January 1962.

Polska Akademia Nauk Zaklad Geofizyki, 1961, Biuletyn Obserwatorium Sejsmologicznego W Warszawie, Nr 15, Rok 1955: Polska Akad. Nauk Zaklad Geofizyki, 115 p., tables.

----------1961, Biuletyn Obserwatorium Sejsmologicznego W Warszawie, Nr 16, Rok 1956: Polska Akad. Nauk Zaklad Geofizyki, 127 p., tables.

----------1961, Biuletyn Obserwatorium Sejsmologicznego W Warszawie, Nr 18, Rok 1958: Polska Akad. Nauk Zaklad Geofizyki, 136 p., tables.

----------1961, Biuletyn Obserwatorium Sejsmologicznego W Warszawie, Nr 19, Wyniki Stalych Obserwacji Mikrosejsmicznych Za Lata 1959 - 1960, Oraz Obserwacji Mikrosejsmicznych W Dniach I Okresach Swiatowych, 1960 Roku, 154 p., tables.

Ringwood, A. E., 1962, A model for the upper mantle: Jour. Geophys. Research, v. 67, no. 2, p. 857-867, 4 figs., 61 refs. February.

Abs. "The occurrence of a low-velocity zone in the upper mantle has been attributed to the effect of high temperature

gradients. If the upper mantle is homogeneous, it is shown that the required temperature gradients would lead to extensive melting. Since this consequence is unacceptable, it appears necessary to consider nonhomogeneous models.

It is assumed that the mantle immediately below the Mohorovicic discontinuity consists dominantly of dunite and peridotite. This passes downward into more primitive material, which is chemically equivalent to a mixture of 1 part of basalt to 4 parts of dunite. For convenience, this hypothetical primitive material is called 'pyrolite'. Within the upper mantle, the pyrolite might occur in either of two principal mineral facies - (i) as the assemblage olivine-pyroxene-plagioclase (plagioclase pyrolite) and (ii) as the assemblage olivine-pyroxene-garnet (garnet pyrolite). There would also be a substantial transition zone between these facies, in which olivine, pyroxene, plagioclase, and garnet coexisted. It is suggested that the low-velocity zone is caused by downward transition from the sub-Mohorovicic peridotite into plagioclase pyrolite (Which has a relatively low seismic velocity) and then into garnet pyrolite. The low-velocity zone is thus due to the presence of plagioclase as a primary phase.

Further aspects of this model are explored. The depths of these various zones probably differ between oceanic, continental margin, and Precambrian shield regions. The model implies that a low-velocity zone may not be present beneath Precambrian shields. In regions which have been recently subjected to diastrophism, the characteristic geotherm may pass for a considerable distance through the transition zone between plagioclase and garnet pyrolite facies. This can give rise to acute thermal and mechanical instability which may in turn cause diastrophism in the crust. Evolutionary relationships between oceanic, active orogenic, and Precambrian shield regions are also discussed in terms of the model."

Sections included: Chemical composition of the upper mantle. Mineral facies in the upper mantle. Upper mantle structure in terms of the proposed model. Oceanic regions. Orogenic regions. Precambrian shields. Crustal instability. Crustal evolution.

Teisseyre, Roman, 1961, Problems of microseismic motion analysis: Polska Akad. Nauk Geofizyki Zaklad, Builetyn Obserwatorium Sejsmologicznego W Warszawie, Nr 19, Wyniki Stalych Obserwacji Mikrosejsmicznych Za Lata 1959 - 1960 Oraz Obserwacji Mikrosejsmicznych W Dniach I Okresach Światowych, 1960 Roku, p. 151-154, 9 refs.

WAVE PROPAGATION

Aliyev, O. Kh. M., 1961, Propagation and reflection of spherical shock waves from free boundary in elastic medium, USSR: Joint Pub. Research Services 9542, 17 p., figs. June 28. Order from OTS, Xerox, $1.60. 61-27076. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 58. January 1962.

Berzon, I. S., 1953, (tr. 1959-1960), A combined plot method for determining the range of refractured and reflected waves: Geophys. Soc. Tulsa Proc., v. 6, p. 29-34, 2 figs., 3 refs.

Translation of Akad. Nauk SSSR, Izv. Ser. Geofiz., no. 3, p. 209-214.

Abs. "A method of determining the zones of refraction and reflection, for the same velocity discontinuity, is developed on the basis of travel time curves plotted for mean velocities. The waves are treated as reflected over the entire length of the detector spread, however."

Brekhovskikh, Leonid M., 1955, (tr. 1960), Waves in layered media: New York, Academic Press, 561 p. Bibliography to 1955. $16.00. Title and review in Geophysics, v. 27, no. 1, p. 169. February. (Transl. from Russian by David Lieberman; transl. edited by Robert T. Beyer).

Ganguli, D., and Banerjee, S., 1960, A study of relationship between compressional wave velocity and stress-strain with some rocks: Jour. Sci. Eng. Research, v. 4, no. 2, p. 275-289. July. Title and review from Appl. Mech. Rev., v. 15, no. 1, p. 29. January 1962.

Rev. "Compressional wave velocity, Young's modulus and Poisson's ratio on three rock specimens in a prism shape have been measured directly and independently under the repeated axial stress. Their changes with pressure show the remarkable hysteresis even under very low pressure (< 150 kg/cm^2). It is shown that the changes of elastic constants and wave velocity, determined directly by experiments, are quite different from the corresponding values calculated from the other quantities by use of the well-known formula (Wood, 1941) in the theory of elasticity. The authors emphasize that the application of the formula is likely to be misleading in such cases, when hysteresis in the stress-strain relation is considerable, and that accumulation of data of repeated stress application may give a clue to clarify the behaviors of such complex mechanical properties of rocks as stated above. Moreover, the suitability of other theoretical formulas to calculate the velocity of compressional wave in rocks under strain is discussed.

The above-mentioned discrepancy may have some relations with the difference of measuring methods between the velocity (dynamical method) and the elastic constants (statical method)." - K. Mogi, Japan.

Hutson, A. R., and White, Donald L., 1962, Elastic wave propagation in piezoelectric semi-conductors: Jour. Appl. Physics, v. 33, no. 1, p. 40-47, 11 refs. January.

Isaacson, E. de St. Q., 1961, Stress waves resulting from rock failure in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 153-161, 8 figs., table, 3 refs. November. Discussion, p. 159-160.

Author's reply, p. 160-161.

Prelim. "In a mine subject to severe rock bursts, the damage in nearby areas which results from the vibrations set up is often considerable. By making simple but realistic assumptions, it is possible to estimate the magnitude of the transient stresses which occur and it will be shown that these may frequently be such as to produce failure in an excavation the peripheral static stresses of which are subcritical.

Certain aspects of design will also be discussed and suggestions made as to how the risk of failure under vibrationary stresses may be minimized by the use of such techniques as wall bolting, or by the correct siting and orientation of the excavation vis à vis the zone in which bursting is feared.

It will also be pointed out that estimates of the energy released in a burst may be derived from two sources: (1) considerations of the energy of the wave train and (2) considerations of the strain energy release at the site. A comparison of these two estimates will frequently indicate that a given burst is not centered at the supposed site but has, in fact, occurred elsewhere. This leads to the possibility of a burst occurring in the solid rock and at areas not immediately adjacent to mining excavations, and evidence is put forward suggesting that this type of bursting does, in fact, on occasion take place."

Sections included: Theoretical account of transient stresses in a particular case. Numerical example. Applications to design. Energy produced by bursts. Rock bursts induced by mining but centered at points remote from excavations. Development of shock wave.

Ivakin, B. N., tr. 1961, The microstructure and macrostructure of elastic waves in one-dimensional continuous nonhomogeneous media: Acad. Sci. USSR Geophys. Inst. Trans. no. 39, 113 p., $6.00. Soviet Research in Geophysics, v. 3. New York, Consultants Bureau Enterprises Inc.

"This book discusses the problems of the structure of waves propagating in continuous nonhomogeneous and generally absorbing media, with a single spatial coordinate, over intervals infinitesimally small or comparable with a wavelength (microstructure) and over intervals larger or appreciably larger than a wavelength (macrostructure). Solutions are obtained for wave problems, in operator form, for absorbing media with: 1) a single interface, 2) two interfaces, and 3) periodically repeating layers. In the cases considered, the micro- and macrostructure of sinusoidal waves of displacement, pressure, and intensity are studied in detail. The possibilities of obtaining solutions to the wave problems in media having smoothly varying parameters are considered. The solutions of the wave problems posed are presented in operator notation, making it possible to study non-steady-state oscillations, although detailed calculations and graphs are given for steady-state sinusoidal oscillations as well."

Contents: Determination of the integral and differential propagation constants of a nonhomogeneous waveguide, and the relationship between them. Determination of the input impedances of a nonhomogeneous waveguide. Incidence of a plane wave normal to the interface separating two elastic half-spaces. Incidence of a plane wave normal to a layer located between two elastic half-spaces. Incidence of a plane wave normal to the layers of a periodically layered elastic medium.

Jones, R. V., 1962, Sub-acoustic waves from large explosions: Nature, v. 193, no. 4812, p. 229-232, 7 figs., 6 refs. January 20.

Microbargraph records of the Russian nuclear explosion, October 30, 1961; recorded with two new design microbargraphs. The instruments are differential, capable of recording 0.1 microbar per division. Comparison with a disturbance originating in Siberia on June 30, 1908.

Rinehart, John S., Fortin, Jean-Pierre, and Burgin, Lorraine, 1961, Propagation velocity of longitudinal waves in rocks. Effects of state of stress, stress level of the wave, water content, porosity, temperature, stratification and texture in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 119-135, 27 figs., 3 tables, 44 refs. November.

Introd. "Propagation velocity of longitudinal stress waves in rocks depends on several factors: the state of stress, stress level of the wave, water content, porosity, temperature, direction of propagation with respect to stratification of the rock and texture. While some of these factors have been studied thoroughly many times, others, such as the stress level of the wave, have not been investigated as yet. This paper reviews and summarizes existing data on propagation velocity of longitudinal stress waves with a view to generalizing the results and indicating areas of weakness and gaps in our knowledge."

Sections included: Broad variation in propagation velocity by rock type. Methods of measurements. Comparison of static and dynamic measurements. Influence of state of stress. Influence of stress level of the wave. Variation with water content. Variation with porosity. Variation with temperature. Variation with stratification. Influence of texture. Field and laboratory measurements. Conclusion.

Stanyukovich, K. P., 1961, The system of shock waves generated by the fall and explosion of meteorites (Sistema Vozdushnykh Udarnykh Voln pri Polete i Vzryve Meteoritov): Space Technology Labs., Inc., Los Angeles, Calif., Rept. no. STL-TR-61-5110-50, 14 p., figs. October. Order from OTS, AD-266 178, $1.60. Unclassified rept. Transl. from Meteoritika. Akad. Nauk SSSR, no. 14, p. 62-69, 1956. Title, abstract and descriptors from U. S. Govt. Research Repts., v. 37, no. 3, p. 5. February 5, 1962.

Transl. by Z. Jakubski.

"A mathematical analysis is given of the shock waves propagated by falling and impacting meteorites. Strong shock waves are generated by a meteorite during its fall since its velocity is nearly always above the local speed of sound. Meteorites which reach the earth's surface disintegrate upon impact; a detonation shock wave is then generated propagating from the center of the explosion. This wave may interact with the ballistic shock wave propagated from the trajectory of the fallen meteorite." - Author.

(continued on next page).

Descriptors: (*Meteorites, *Shock waves, *Impact shock, Explosions, Falling bodies, Flight paths, Detonation waves, Ballistics, Wave transmission.) (Air, Pressure, Density, Volume, Motion, Velocity.) (Equations, Energy, *Mathematical analysis.)

Yoshiyama, Ryoichi, 1960, Stability of waves through a heterogeneous medium and apparent internal friction: Earthquake Research Inst. Tokyo Bull., v. 38, p. 467-478. Title and review from Math. Rev., v. 22, no. 11B, p. 2038-2039. November 1961.

Rev. "An attempt has been made to explain theoretically the observed attenuation coefficient of seismic waves and their dependence on the wave periods. The problem has been further simplified by assuming that the property of the medium changes only in one direction and the wave equation reduces to a one-dimensional one. The special case in which the density of the medium is constant and the structure varies periodically, leading to a wave-velocity distribution in the form of $(1 + b \cos mx)$ in the direction of the x-axis, has been solved." - S. K. Chakrabarty (Howrah).

American Geophysical Union Transactions, 1961, World-wide installation of standard seismic equipment: Am. Geophys. Union Trans., v. 42, no. 3, p. 322. September.

"Installation of modern seismographic equipment at 125 earthquake recording stations in 65 countries and islands was started in mid-1961 and is scheduled for completion in late 1962. Technicians of the Coast and Geodetic Survey, with financial support of the Advanced Research Projects Agency (ARPA) of the Department of Defense will install the instruments. The object of this program, part of the Vela-Uniform project of ARPA, is to provide sensitive standardized instruments for the quantitative study of earthquakes, earthquake mechanisms, seismic wave propagation, and energy. The equipment having a value of approximately $2,000,000 is being supplied by The Geotechnical Corporation of Garland, Texas."

Bobryshev, G. I., 1961, New method for preparation of reservoir strata for hydraulic fracturing, USSR: Joint Pub. Research Services 10767, 18 p. October 25. Order from OTS, Xerox, $1.60. 62-13319. Title from Monthly Cat. U.S. Govt. Pubs., no. 804, p. 73. January 1962.

Carson, A. Brinton, 1961(?), General excavation methods: F.W. Dodge Corp., Department EE, 119 West 40 St., New York 18, N. Y., 392 p. $12.85. Title and review in Excavating Engineer, v. 56, no. 1, p. 46-47. January 1962.

"......handbook designed specifically for those whose work involves earth and rock excavation, ground water control, and bank stabilization. It examines in detail the procedures and equipment used in all classes of excavation, and indicates the rigs most suited to performing each class of work. Each page of text is faced with a full page of line drawings......".

Durelli, A. J., Morse, S., and Parks, V., 1962, The theta specimen for determining tensile strength of brittle materials: Materials, Research and Standards, v. 2, no. 2, p. 114-117, 6 figs. February.

"The measurement of the tensile strength of brittle materials presents several problems. One of these problems, which is associated with the testing of conventional tensile specimens, is the difficulty of applying a truly axial load in the test area. This paper presents a new type of specimen that greatly reduces the alignment problem. The new specimen, called 'theta' because of its shape, when loaded under compression is subjected in the central bar to a uniaxial tensile stress. The specimen has been designed so that failure occurs in the central bar.

Photoelastic and moire analyses were used to determine the stress and strain in the central bar. The photoelastic analyses also show that the alignment of the specimen is not critical and can be done 'by eye'.

A short series of tests were conducted on a theta specimen made of CR-39 (a plastic used in photoelastic work). Satisfactory results were obtained."

Sections included: Forming. Alignment of load. Stress and strain analysis of the specimen. Restrictions on computation of stress. Alignment of the specimen. Secondary failures on the specimen. Testing. Summary.

Electronics, 1962, Sensors seen as boon to the earth sciences: Electronics, v. 35, no. 9, p. 25. March 2.

"Three-day symposium on the applications of electronic sensors in the earth sciences was held two weeks ago at the University of Michigan's Institute of Science and Technology under a tri-service contract administered by the Office of Naval Research.

......Sensors might also be used to......predict earthquakes and volcanic eruptions......"

Farson, Bob, 1962, Two Moran Bros. rigs drill Carlsbad atomic test holes: Drilling, v. 23, no. 3, p. 67-68, 6 figs. January.

Diagram showing "The Shaffer preventers and piping detail as used on the large hole".

Gray, K. E., and Gatlin, Carl, 1961, Photographic study of rock failure in drag bit drilling in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 237-241, 8 figs., 10 refs. November.

Introd. "Rotary drilling with fixed blade (drag) bits has long been practiced by the mining and petroleum industries, and considerable study has been given to defining their cutting action in terms of the pertinent variables.

Fairhurst, and later Fairhurst and Lacabanne, made illuminating studies of drag bit drilling, which showed the effects of certain bit design variables on both percussion and drag bit devices. They employed photographic techniques quite similar to those of this work except at much lower speeds. It was shown in their work that drilling of rock in the brittle state was a cyclical process, in which instantaneous loads on a bit varied from some maximum value to near zero.

Goodrich has presented further data on the subject as well as a qualitative description of this drilling process. Again the postulated failure mechanism is periodic with alternate chipping and crushing periods. According to Goodrich the volumes removed by the grinding and chipping phases are approximately equal.

The same basic 'drilling' problem occurs in the metal cutting industries. Here the literature is more voluminous but the state of knowledge is still not very advanced, as may be discovered from a recent and comprehensive survey of their literature. Metals, however, are more subject to analysis by the classical mechanics of elasticity and plasticity theories than are rocks. It is interesting to note, however, that Hill prefaces his discussion of machining with an admission that the solution to the real problem is not known. A photoelastic solution for the stress distribution ahead of a metal cutting tool appears in the classical book of Coker and Filon.

No fundamental analysis of drag bit drilling appears in the oil industry literature; however, several investigators have studied the hydraulic aspects of cutting removal. Recent developments in drag bit design have renewed oil industry interest in the problem. Furthermore, it is well known that roller bits also employ varying degrees of drag bit action; hence any improvements in basic knowledge can also be applied to their design.

This paper presents preliminary experimental results of two dimensional cutting of some sedimentary rocks by a fixed blade. The rock samples were unconfined in all tests. All 'cuts' were horizontal; hence the true helical path of an actual drill bit was not simulated."

Sections included: Experimental apparatus and procedure. Apparatus. Experimental procedure. Results and discussions. Conclusions.

Gol'tsman, F. M., and Keil'man, Yu. N., 1961, A universal filter for seismic signals: 9 p., 5 refs. Order from OTS or SLA, $1.10. 61-28207. (DSIRLLU) M 4057. Transl. of Prikladnaya Geofizika, no. 25, p. 55-65, 1960. Title, abstract and descriptors from Tech. Transl., v. 7, no. 3, p. 132. February 15, 1962.

"A variant of a universal filter is described, in which delay lines are used as 'memory' cells. The scheme described does not require preliminary recording and subsequent reproduction of oscillations, as it produces a filtered signal at the output of the circuit in proportion to its intake into the circuit. The instrument has been developed in the Laboratory for the Dynamics of Elastic Media of Leningrad State University and can be used for the frequency filtration of any signals presented in the form of electric current oscillations, the spectrum of which lies in the seismic range of frequencies."

Descriptors: *Seismic waves, Separation, *Electric filters, Design Delay lines, Frequency, Circuits, Operation, Tests.

Khalevin, N. I., and Barykin, D. D., 1961, A system for acoustic investigation in boreholes: 11 p. Order from ATS, ATS-64N53R, $15.25. Transl. of Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 69-78, 1961. Title and descriptors from Tech. Transl., v. 7, no. 3, p. 134. February 15, 1962.

Descriptors: *Boreholes, Acoustics.

Klugmann, I. Yu., and Lerner, B. L., 1961 (tr. 1962), The programing of kinematic corrections in a machine for the automatic calculation of profiles from results of seismic surveys: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, (English Transl., January 1962), p. 978-982, 3 figs. October.

"A general investigation is carried out of the calculations performed by machines for automatically constructing profiles from seismological data obtained by the method of reflected waves. Two types of machine, different in principle, are discussed, and their ranges of application are indicated.

The programing of machine operation for regions of predominantly sloping structures is investigated. A simplified rule for programing these machines is proposed, that ensures the necessary accuracy of operation."

Sections included: The transformation of the reflected-wave travel time curve. The programing of a machine with movable elements. Simplified programs. Simplified programing for machines with signal-reading delay. Conclusions.

McAdam, R., 1962, Wireless communication underground: Colliery Guardian v. 204, no. 5256, p. 54-57, 2 figs., 2 tables. January 11.

Description of the radio apparatus developed which will transmit messages through rock over distances varying from 800 ft. to 4300 ft.

Sections included: Design of equipment. Equipment characteristics. Practical test results.

McGhee, Ed., 1962, New drill ship is largest, and first designed solely for drilling service: Oil and Gas Jour., v. 60, no. 8, p. 98-101, 5 figs. February 19.

Plan diagram of the new drill ship "Cuss II".

Panek, Louis A., 1961, Methods for determining rock pressure in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 181-184, 2 refs. November.

Sections included: Change of rock stress determined with a device that responds to deformation only. Change of rock stress measured with a device that has a modulus matched to the rock modulus. Change of rock stress determined with a device that responds to rock deformation and stress in an arbitrary manner. Some methods for determining existing rock stress.

Pittman, Forrest C., Harriman, Don W., and St. John, James C., 1961, Investigation of abrasive-laden-fluid method for perforation and fracture initiation: Jour. Petroleum Technology, v. 13, no. 5, p. 489-495, 16 figs. May.

Abs. "This paper mentions briefly the history of hydraulic jetting as applied to perforating and fracture initiation. It points out the advantages of hydraulic perforation and undercutting as an aid for creating a fracture at the point desired rather than depending upon the weakest point in the formation for breakdown.

It describes early experimental work with jet nozzles in search of better nozzle materials. The effect of splash-back damage and its subsequent influence on jet body and

tool design during this work is discussed.

A series of cutting-rate curves for jets cutting steel and steel-cement-formation combinations is presented to show the effect of hydrostatic head and the point of diminishing returns with respect to cutting time.

There is a series of photographs showing various types of rock formation in which perforation and undercutting tests were made. These stones were drilled and the casing cemented in place as in an actual well. The casing was perforated and circularly cut as if preparing for a fracturing job.

The conclusion reached in the paper is that hydraulic jetting with sand-laden fluid can be used for perforating and undercutting casing, cement and formation rock for the intended purpose of inducing the formation to fracture at a desired point."

Sections included: Equipment. Analysis of the problem. Procedure. Conclusions.

Professional Engineer, 1961, Nuclear device features push-button: Prof. Engineer, v. 46, no. 3, p. 708. October 31.

"A new push-button nuclear device for making rapid measurements of the density and moisture in soils, aggregates and pavements has been developed.

The portable instrument, called the 'Hydro-Densimeter,' will permit inspectors (or contractors) to take a reading of both the moisture and density of material being compacted - in just 60 seconds. A series of three readings to verify uniformity of these conditions takes less than 5 minutes.

The new electronic device is expected to be in great demand by both contractors and inspectors on highway, airstrip and dam work and a host of other construction projects. The 'Hydro-Densimeter' system differs from other such nuclear devices in that it is composed of only two components, instead of three, and employs a radio-active material the use of which does not require licensing by the Atomic Energy Commission......"

Reed, John J., and Mann, C. David, 1961, Flat jacks pre-load massive mine supports in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 211-219, 10 figs., 2 tables, 9 refs. November.

Introd. "The work described in this paper has been a joint effort of the Mine Research Department and the Mine Operating Department of the St. Joseph Lead Co., to develop stronger more effective concrete pillars for underground mine support. During the past 30 years, concrete pillars up to 12 ft. in diameter by 50 ft. in height have been built occasionally where needed in the Southeast Missouri lead mines. In at least two instances, such pillars were built with the object of 100 per cent recovery of high-grade ore pillars, but generally, and certainly with present costs, these pillars are used only to safeguard important installations. To measure subsequent loading of the pillars, four vertical stainless steel rods have been cast in just beneath the surface of the concrete, and at 90 deg intervals around the circumference of the pillars. These rods are anchored in the concrete at the top of the pillar and hang freely inside a pipe. At the base of the pillar, the rod enters a junction box where the rod's free end hangs about 6 in. above the upper end of a similar short rod which is imbedded in the concrete of the pillar base. The gap between these rod ends is precisely measured with an inside micrometer. Any decrease in this gap is equal to the total compression of the pillar within a height equal to the length of the rods. Past experience, substantiated by 20 years of compression measurements on pillars built in 1938, has demonstrated that concrete pillars which are not pre-loaded will never carry appreciable weight by natural loading until the roof rock and adjacent rock pillars are already failing. By that time it is too late; the roof caves away from the pillar, and it stands visible for a time in the rock pile, intact, but useless. In early attempts at pre-loading, some 16 screw jacks were placed atop the pillars and tightened against the roof. However, their total force was only of the same order as the weight of the pillar itself, about 80 psi on the pillar area, and a much more powerful pre-loading force was clearly required. Thesis work in mining engineering at the University of California, and subsequent knowledge of the use of flat jacks in France, led to the solution described in this paper."

Sections included: Pillar construction. Pillar pre-loading. Results. Structural considerations. Conclusions.

Rinehart, J. S., 1960, Stresses associated with lunar landings: Jour.,British Interplanetary Soc., v. 17, no. 12, p. 431-436. November-December. Title and review from Appl. Mech. Rev., v. 15, no. 1, p. 28. January 1962.

Rev. "Results of experimental studies of projectile penetration in rock and sand are described. These results are then applied to the determination of gross stresses in impacting space vehicles." - R. A. Eubanks, USA.

Rock Products, 1962, What's happening: Rock Products, v. 65, no. 1, p. 12, January.

"Three-dimension pictures of an explosion are now possible with a new camera that can accelerate film from a standstill to 15,000 frames a second in just over half a second. This development could provide first-hand knowledge of many high-energy industrial processes, claims its designer, Benson-Lehner Corp. Two side-by-side 16mm images are produced on one 35mm strip by the use of two tilted mirrors placed along tracks in front of the camera. For showing purposes, a special projector slows the film."

Shawver, George L., 1962, Shock sub pays off in deep drilling: World Oil, v. 154, no. 1, p. 57-59, 3 figs., 2 tables. January.

"New tool increases penetration rate in rough drilling areas, reduces surface vibrations, and minimizes downhole tubular fatigue failures."

Rubber element between the outer barrel and the inner mandrel of the shock sub reduces vibrations.

Sections included: How the shock sub works. Increased penetration rate. Drill collar troubles reduced. Damage to dropped drill string reduced.

Sherwood, J.W.C., 1962, The Seismoline, an analog computer of theoretical seismograms: Geophysics, v. 27, no. 1, p. 19-34, 9 figs., table, 13 refs., appendix. February.

"A description is given of the Seismoline, an electrical analog computer of theoretical reflection seismograms involving all primary and multiple reflections. The computer utilizes an analogy between seismic wave propagation through a stratified earth and electrical wave propagation along a lumped-parameter transmission line. A description is given of the prototype Seismoline and the experimental tests performed on it. It is

concluded that it provides a convenient, speedy, and sufficiently accurate computer for the quantity production of theoretical seismograms, except possibly in cases where the acoustic impedance contrasts of the geologic section are extremely low. Changes in the velocity and thickness of the various geologic layers may be made with ease, and the resulting changes on the seismogram can be viewed almost simultaneously. This inherent flexibility introduces the possibility of a feedback process whereby an operator might modify his filter settings or the geologic model in order to effect a better match between corresponding theoretical and field seismograms."

Sections included: Introduction. Contemporary techniques for constructing theoretical reflection seismograms. The Seismoline approach to theoretical seismograms. Electrical analog of a stratified earth. Representation of a stratified earth. The value of the depth increment. Extension to include density variations and lateral geologic changes. The experimental Seismoline. Seismoline scaling factors. Description of operation. Basic tests applied to the Seismoline. Impulse noise test. Pulse reflection and transmission coefficients. High velocity stratum. Linear velocity transition zone. Continuous sine wave excitation. Amplitude decay with transit time. Repeatability of Seismoline output. Comparison of digital and analog theoretical seismograms in an area of moderate to high reflection coefficients. Comparison of digital and analog theoretical seismograms in an area of low reflection coefficients. Assessment of basic tests. Conclusion.

van Lingen, N. H., 1962, Bottom scavenging - A major factor governing penetration rates at depth: Jour. Petroleum Technology, v. 14, no. 2, p. 187-196, 19 figs., 4 tables, 9 refs., appendix. February.

Abs. "A laboratory study has been made to determine what factors affect the penetration rate of roller bits, diamond bits and drag bits in rock drilling with clay/water muds. The rather simple relations that exist when pressures in and around the borehole are equal become more complicated when under down-hole conditions the penetration rate is hampered by the existence of a pressure differential between the mud at the hole bottom and the pore liquid at cutting depth. Expressions that have been derived for both the penetration rate and the magnitude of the pressure differential in permeable rock together fully account for operating, rock, mud and bit variables. In impermeable rock a similar pressure differential is caused by the bit action itself.

In all cases, the pressure differential and the reduction in penetration rate increase with the effectiveness of the plastering at the bottom of the hole by mud particles. Where bits are employed whose action is largely that of crushing, however, the plastering may become even more effective owing to the addition of rock particles rubbed into the pores of the rock. With roller bits, a plastically behaving layer may be formed, which causes a further reduction in penetration. In the case of bits whose action is chiefly scraping, moreover, penetration may be arrested by the bit's becoming balled-up.

The various adverse effects are reduced by thorough scavenging of the hole bottom. This paper shows how with jet bits the efficiency of such scavenging may be improved by suitable choice of the position of the nozzles."

Sections included: Equipment. High-pressures machine. Fifteen-tons machine. Five-tons machine. Rocks. Bits. Muds. Atmospheric drilling. Effect of down-hole pressures. Effect of overburden. Static hold-down and rock strengthening (permeable rock). Estimation of hold-down pressure in permeable rock. Hold-down with rock of low permeability. Clogging and balling-up of the hole bottom. Balling-up of the bit. Bottom scavenging. Appendix A. Petrographical description of rocks used. Appendix B. Estimation of hold-down pressure in permeable rock.

Vasil'yev, Yu. M., and Charygin, M. M., 1961, On prospects of super deep drilling, USSR: Joint Pub. Research Services 10626, 10 p., refs. October 19. Order from OTS, Xerox, $1.10. 62-13231. Title from Monthly Cat. U. S. Govt. Pubs., no. 804, p. 69. January 1962.

Wilson, A. H., 1961, A laboratory investigation of a high modulus borehole plug gage for the measurement of rock stress in Symposium on Rock Mechanics, 4th, University Park, Pennsylvania, March 30-April 1, 1961: Pennsylvania State Univ., Mineral Industries Expt. Sta. Bull. 76, p. 185-195, 20 figs., 3 tables, 6 refs. November.

Introd. "An excavation at depth underground is kept open by virtue of the stability of the strata which surround it and this stability depends to a great extent on the magnitude of the stress and how it is distributed around the excavation. Therefore the measurement of stress and how it varies is highly desirable in any investigation concerned with strata control. In addition the workability of the coal is influenced by the stress distribution immediately ahead of the face, and a knowledge of the magnitude and distance ahead of the stress abutment will be of assistance in the winning of the coal.

The measurement of the absolute value of the stress is extremely difficult, and a satisfactory means of accomplishing this in the types of rock encountered in coal measures has not yet been found. The measurement of change of stress is, however, very much more simple, and descriptions of a number of instruments suitable for the purpose have already been published. These instruments are designed for positioning at the ends of boreholes in the rock, and the strain changes in the instruments are interpreted in terms of stress changes in the rock. In general, either the instruments must be calibrated in specimens of the rock in which they are to be used or the stress-strain relationships of the rock and plugs must be accurately known. In practice it is frequently difficult to meet either of these requirements, and a means of measuring the change of stress in rock which does not require a laboratory sample or an accurate knowledge of the elasticity of the rock is desirable.

Coutinho in 1949 suggested the use of inclusions of relatively high modulus of elasticity as instruments for the determination of stress in concrete. Provided the overall modulus of the instrument is substantially greater than that of the concrete, the strain in the instrument is theoretically dependent on the stress and not the strain, and an accurate knowledge of the concrete stress-strain relationship is not required. This suggestion is as equally applicable to rock, and this paper describes a suitable instrument and presents the experimental work carried out to prove its suitability when used in rocks of various moduli of elasticity."

Sections included: Theoretical considerations. Basic formulae. Choice of design and material. Borehole plugs used in experiments. General description. Stability and temperature coefficients. Cross-sensitivity. Borehole plugs set in rock with Araldite cement. Stone plugs in slabs of rock. Brass plugs in slabs of rock. Brass plugs in cubes of rock. Consideration of results. Borehole plugs set in rock with expanding cement. Effect of foreign material around plug. Experimental verfication. Borehole plugs embedded in broken material. Conclusions.

Wilson, A. H., 1962, The measurement of rock stress: Colliery Guardian, v. 204, no. 5258, p. 118-122, 124-125, 126-127, 10 figs., 3 tables, 6 refs. January 25.

World Oil, 1962, Project Vela's new data analysis center: World Oil, v. 154, no. 2, p. 11. February 1.

"A $3 million installation at Washington, D. C., is expected to be active by June 1, 1962; new facility will maintain a master central computer file of underground explosions and earthquake recordings all over the world. Basic data will be reported from more than 40 recording stations, both fixed and mobile. In addition to developing and testing new methods of nuclear detection and identification, the center will furnish fundamental information on seismology."

MISCELLANEOUS

Hahn, G. T., and Jaffee, R. I., no date, A comparison of the brittle behavior of metallic and nonmetallic materials: Battelle Memorial Inst. Order from OTS, PB 171 626, \$0.50. Title from Mech. Eng., v. 84, no. 1, p. 85. January 1962.

Jones, A., 1962, Surface wave techniques for measuring the elastic properties and thickness of roads; theoretical development: British Jour. Appl. Physics, v. 13, no. 1, p. 21-29, 7 figs., 9 refs. January.

"The theoretical development of the experimental technique for measuring the elastic properties of the layers which make up a road is described. A knowledge of these properties is required in the development of a fundamental method of pavement design. The elastic properties are deduced from measurements of the wavelength and velocity of vibrations of known frequency along the surface of the road and this paper develops the theory of the method of analysis of the relation between velocity and wavelength for single- and two-layered pavements."

Jones, Kevin R., 1962, On the differential form of Darcy's law: Jour. Geophys. Research, v. 67, no. 2, p. 731-732, 4 refs. February.

Abs. "It is shown that the differential form of Darcy's law cannot be of the form $u = -[\nabla (kP/\mu) + pgk/\mu]$ as has been suggested. Instead, the commonly used $u = k/\mu (\nabla P + pg)$ is correct."

Knudsen, W. C., 1962, Equations on fluid flow through porous media - incompressible fluid of varying density: Jour. Geophys. Research, v. 67, no. 2, p. 733-737, 4 figs., 5 refs. February.

Abs. "The equations governing the flow of fluid through porous media are derived for those situations in which the fluid may be considered incompressible but continuously varying in density. The equations are used to obtain an analytic solution for the instantaneous velocity field for a simple model. A simply computed trial solution is compared with the analytic solution and shown to be adequate throughout most of the model."

McCance, Andrew, 1962, Stress extension relations for solids: Iron and Steel Inst. Jour., v. 200, pt. 1, p. 23-27, 11 figs., 3 tables, 4 refs. January.

Synop. "Geometrical considerations show that a simple shear in a cube of material implies the existence of anelastic strains as well as elastic strains. This leads to a modified Hooke's law given by

$$S = Gx/\left(1 + \frac{G^2x^2}{K^2}\right)^{\frac{1}{2}}$$

where K is the yield stress. In the plastic range it is shown that when the internal elastic dilatation stress is taken into account, the relation between stress and strain for small values is $S^2 \alpha x$ and the development of this relation for large extensions $S^2 \alpha x$ gives the relation

$$S = R\left(\frac{bx}{1 + bx}\right)^{\frac{1}{2}}$$

where R is the flow stress. A geometrical interpretation of this relation is given.

Strain hardening arises from the modification of the dilatational stress by plastic displacement and the consequent volume changes produce a hardening of the flow stress given by $R = R_o (1 + G \log (1 + x))$ and an increasing resistance to strain. Precise relations between the coefficients given and fully supported by experimental results on mild steel, copper, aluminium, and lead. An empirical relation between the flow stress and the product of the lattice constant and Young's modulus has been found for the four metals examined."

Sections included: Stresses below the yield stress. Stress extension in the plastic range. Strain hardening. Relations between coefficients.

New Scientist, 1962, The Upper Mantle Project in Canada: New Scientist, v. 13, no. 270, p. 155, fig. January 18.

Discusses the Upper Mantle Project, to be undertaken by scientists over the world. Canadian phase to include two drill holes, 10,000 feet deep (1) into the ultra basic inclusion at Muskox, and (2) Mount Albert. Studies to include: geological surveys, aeromagnetic surveys,

rock magnetism studies of an extensive dike system, geophysical measurements and observation of meteorite craters.

Olszak, W., 1961, On the application of the theory of plasticity of non-homogeneous bodies in engineering: A Magyar Tudományos Akadémia Műszaki Tudományok Osztályának Közleményei (Hungarian Acad. Sci. Eng. Class Proc.), v. 28, no. 1-4, p. 217-236. Title from Hungarian Tech. Abs., v. 13, no. 4, p. 153.

Olszak, W., and Urbanowski, W., 1961, On basic problems of the theory of anisotropic nonhomogeneous elastoplastic bodies: A Magyar Tudományos Akadémia Műszaki Tudományok Osztályának Közleményei (Hungarian Acad. Sci. Eng. Class Proc.), v. 28, no. 1-4, p. 203-215. Title from Hungarian Tech. Abs., v. 13, no. 4, p. 153.

FUTURE SYMPOSIA

American Association of Petroleum Geologists - Society of Economic Paleontologists and Mineralogists, annual meeting, San Francisco, March 26-29, 1962. Sponsored by Pacific Section of American Association of Petroleum Geologists. Titles and abstracts from Am. Assoc. Petroleum Geologists Bull., v. 46, no. 2, p. 259-284. February.

Selected authors and abstracts of papers to be presented at the meeting.

Eaton, J. P., Pakiser, L. C., Jackson, W. H., Stewart, S. W., and Stuart, D. J., Exploring the continental crust of western United States. (p. 265).

Abs. "Seismic-refraction measurements have been made by the U. S. Geological Survey along 10 profiles, each 300 km. long or more, in California and adjacent Nevada, and Colorado and adjacent New Mexico, as a part of the Vela Uniform program of the Advanced Research Projects Agency, Department of Defense. Initial interpretation of results along a line from Fallon to Eureka, Nevada, defines an intermediate crustal layer at a depth of about 22 km. with a velocity of 7.2 km. per sec., and the Mohorovicic discontinuity at a depth of about 40 km., below which the velocity is 8.0 km. per sec. Interpretation of the first profile completed in Colorado defines an intermediate crustal layer at a depth of about 31 km. with a velocity of 6.9 km. per sec., and the Mohorovicic discontinuity at a depth of about 48 km., below which the velocity is 8.0 km. per sec. The velocity in the upper crustal layer, below the near-surface rocks, is 6.1 km. per sec. along both profiles."

Hamblin, W. K., Internal structure of massive sandstones. (p. 268).

Abs. "The structure of 306 samples of seemingly homogeneous massive sandstone from 74 formations was studied by use of radiography. This technique consists of placing a large thin slice of rock directly upon photographic film and exposing it to an X-ray source from a standard medical or industrial X-ray unit. The image recorded on the emulsion depends on differences in X-ray absorption by the various constituents in the rock sample. Density variations between quartz and heavy minerals, clays, and other minor impurities are recorded on the radiograph and clearly outline the internal structure of the rock.

The results of this study show that sandstones that seem to be homogeneous, massive, and completely structureless in outcrop and hand specimen actually contain a definite systematic arrangement of grains into small structural units. These units may be horizontal laminae, cross-laminae, micro-cross-laminae, disrupted bedding, or other types of stratification. A massive bed may contain only one structural type or several types in various combinations. The type of structure present seems to be related to grain size. Micro-cross-laminae and disrupted bedding are most common in the fine-grain deposits, whereas large-scale cross-laminae are restricted to coarser sediments.

It is concluded that massive sandstones do not represent special environmental conditions but were formed by the same processes that produce well stratified deposits. On the basis of this study it is doubtful that any sandstones are completely structureless and isotropic throughout."

Riedel, William R., Geological and geophysical implications of Mohole Project. (p. 276).

Abs. "The technical success of the experimental drilling phase of the Mohole Project, in 11,700 feet of water, 40 miles east of Guadalupe Island, in March and April, 1961, has provided a new tool for geological and geophysical studies of the ocean floor. Cores were obtained from the 550 feet of Late Tertiary sediments and 44 feet of basalt penetrated there - some of the results of investigations on that material (not available for quotation at the time of preparation of this abstract) will be reported at the March meeting. Samples obtained from the deep crust under ocean basins in later phases of this project may be expected to provide data on changes through time in the amounts and proportions of materials removed from continents (essential for considerations of geochemical balance, and hitherto available only for post-Cretaceous), on the origin of major submarine topographic features, and on biological history during the Lipalian interval. Samples of the mantle should contribute to our understanding of the processes of differentiation of crust, mantle, and core, the evolution and possible mobility of continental and oceanic crusts, and physical properties involved in geomagnetism and other major geophysical phenomena."

Robinson, Robert B., Textural classification of reservoir rocks. (p. 276).

Abs. "The porosity of a reservoir rock is best described by the size, shape, and arrangement of the pores comprising this porosity, rather than in terms of gross per cent. It is as important for a petroleum geologist to be able to predict the probably producing characteristics of a reservoir rock as it is for him to know the precise location of a new reservoir. With this in mind, a textural classification of reservoir rocks has been devised to assist well-site geologists in differentiating producing from non-producing zones in a reservoir body. The classification is based on an empiric association between rock textures as viewed on a polished surface and producing characteristics as determined by capillary pressure, porosity, and permeability measurements."

Wagner, Fred J., Machine digitizing and processing of geological data obtained from well logs. (p. 283).

American Society of Civil Engineers, Pacific Southwest Council Convention, El Cortez Hotel, San Diego, Calif., April 5-7, 1962.

Fifth Rock Mechanics Symposium, University of Minnesota Institute of Technology, Minneapolis, Minnesota, May 3-5, 1962. Sponsored by mining departments of Colorado School of Mines, Missouri School of Mines and Metallurgy, Pennsylvania State University, and University of Minnesota.

International Mineralogical Association, 3rd general meeting, Washington, D. C., April 17-20, 1962. Sponsored by Mineralogical Society of America. Program and abstracts in Am. Mineralogist, v. 47, no. 1 and 2, p. 177-210. January-February 1962.

Symposium on Layered Intrusions

Cameron, E. N., Structure and rock sequences of the critical zone of the eastern Bushveld Complex.

Emeleus, C. H., Structural and petrographic observations on layered granites from S. W. Greenland.

Ferguson, J., and Pulvertaft, T. C. R., Contrasted styles of igneous layering in the Gardar province of S. Greenland.

Gunn. B. M., Differentiation in Ferrar dolerites, Antarctica.

Hunter, H. E., Layered basic intrusive rocks of the Wichita Mountains, S. W. Oklahoma.

Irvine, T. N., Mineralogy and petrology of the ultramafic complex at Duke Island, S. E. Alaska.

Jackson, E. D., Stratigraphic and lateral variation of chromite compositions in the Stillwater complex.

(continued on next page).

Jahns, R. H., and Tuttle, O. F., Layered pegmatite-aplite intrusions.

Loomis, A. A., Norite anorthosite bodies in the Sierra Nevada batholith.

Naidu, P. R. J., A layered complex in Sittampundi, Madras State, India.

Smith, C. H., and Kapp, E. H., The Muskox intrusion, a newly discovered layered intrusion in the Coppermine River area, N. W. Territories, Canada.

Speed, R. C., Layered picrite-anorthositic gabbro sheet, West Humboldt Range, Nevada.

Thayer, T. P., Flow layering in alpine-type peridotite-gabbro complexes.

Wadsworth, W. J., The Kapalagulu layered intrusion of Western Tanganyika.

Wager, L. R., The mechanism of deposition and solidification of the Skaergaard layered series, E. Greenland.

Wilshire, H. G., Internal structure of a differential teschenite intrusion, Prospect Hill, New South Wales.

National Limestone Institute, 17th annual convention, Statler-Hilton Hotel, Washington, D. C., June 18-21, 1962.

Pacific Southwest Minerals Industry Conference (AIME), Palace Hotel, San Francisco, Calif., April 12-14, 1962.

NEW PUBLICATIONS

Academy of Sciences of the USSR, O. Yu. Shmidt Institute of Earth Physics, tr. 1961, Seismic effects of underground explosions: New York, Consultants Bureau Enterprises, Inc. (in preparation).

Keilis-Borok, I., Differences between spectra of surface waves of earthquakes and underground explosions.

Pasechnik, I. P., Kogan, S. D., Sultanov, D. D., and Tsibul'skii, V. I., Results of seismic observations of underground nuclear and TNT explosions.

Riznichenko, Yu. V., On the seismic magnitude of underground nuclear explosions.

Vavilova, T. I., and Gel'chinskii, B. Ya., Theoretical model of explosions at boundary limits.

Gumenskii, B. M., and Komarov, N. S., tr. 1961, Soil drilling by vibration: New York, Consultants Bureau Enterprises, Inc. (in preparation).

"The authors present a comprehensive analysis of thixotropic changes (liquefaction and subsequent solidification) in soils, explaining the physical basis of the vibrodrilling process.

In addition to basic information on thixotropy and the effect of vibration on unconsolidated soils, numerous designs of modern vibrodrilling equipment are presented. Data on the precision of geological sections measured in holes made by vibrodrills and the state of preservation of soil samples are given. The processes originating in soils during vibrodrilling and the relationships between these processes and the nature of the soils are considered.

The final chapter outlines practical methods for using the vibrodrilling technique to best advantage."

Ostrovskii, A. P., tr. 1961, New rock breakdown processes for deep-well drilling: New York, Consultants Bureau Enterprises, Inc. (in preparation).

"This volume discusses the processes of shattering rocks by impulses of high pressure of different intensities and duration (high-pressure jets of liquid, pressure in liquid during the closing of vacuum pockets, acoustical waves and cavitation, electrical discharge in liquid, underwater explosions) and also deals with thermal processes of shattering rocks (high-temperature jets of gas, plasma, high-frequency currents) suitable to conditions of drilling deep holes filled with liquid. The explosive process of drilling deep holes is treated in detail. Scientists, engineers, and technical workers in the petroleum, coal, and mining industries, as well as specialists in explosive operations, will find this book of exceptional value."

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MONTHLY INDEX, RUSSIAN ACCESSIONS

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Monthly index page number appears in parenthesis following the complete citation, for example, Russian Accessions (R. A., p. 800). Unless otherwise stated all articles are in Russian.

Adushkin, V. V., and Sukhotin, A. P., 1961, Destruction of a solid medium by blasting: PMTF; zhurnal prikladnoi mekhaniki i tekhnicheskoi fiziki (PMTF; Jour. of Appl. Mechanics and Tech. Physics), no. 4, p. 94-101. July-August. (R. A., p. 2640).

Akademiia Nauk SSSR. Komitet po geodezii i geofizike, 1960, Soobshchenie o nauchnykh rabotakh po geomagnetizmu i aeronomii 1957-1959 gg.; predstavliaetsia v Mezhdunarodnuiu assotsiatsiiu geomagnetizma i aeronomii k XII General'noi assemblee Mezhdunarodnogo geodezicheskogo i geofizicheskogo soiuza (Account of scientific work on geomagnetism and aeronomy during the period 1957-1959; presented to the International Association of Geomagnetism and Aeronomy on the occasion of the 12th General Assembly of the International Union of Geodesy and Geophysics): Moskva, 154 p. (R. A., p. 2698).

Alymkulov, Zh. A., and Medvedev, K. D., 1960, Physicomechanical properties of coals and enclosing rocks of the Kara-Kechinskoye brown coal deposit: Akad. Nauk Kirgizskoi SSR, Frunze. Izvestiia. Seriia estestvennykh i tekhnicheskikh nauk (Acad. Sci. Kirghiz S.S.R. Bull. Ser. in Natural and Technol. Sci.), v. 2, no. 2, p. 3-20. (R. A., p. 2720).

Anonymous, 1961, Contribution of the scientific-research institutes to the 22d Congress of the CPSU: Sovetskaia geologiia (Soviet Geology), v. 4, no. 7, p. 3-5. July. (R. A., p. 2697).

Ardishvili, A. A., 1960, Problem of using the analytical method for calculating rock pressure on a pliable support of individual workings in the mines of the Akhaltsikhe deposit: Akad. Nauk Gruzinskoi SSR, Tiflis. Institut gornogo dela. Trudy (Acad. Sci. Georgian S.S.R. Inst. of Mining. Trans.), no. 2, p. 65-69. (R. A., p. 2620).

Aronovich, Z. I., 1961, Study of local disturbances during observations at seismic stations of the Crimean zone (English summ.): Mezhdunarodnyi geofizicheskii god; informatsionnyi biulleten' (The Internat. Geophys. Year; Inf. Bull.), no. 4, p. 101-106. (R. A., p. 2665).

Barenblatt, G. I., 1961, Mathematical theory of equilibrium cracks forming in brittle fracture: PMTF; zhurnal prikladnoi mekhaniki i tekhnicheskoi fiziki (PMTF; Jour. of Appl. Mechanics and Tech. Physics), no. 4, p. 3-56. July-August. (R. A., p. 2804).

Bedcher, A. Z. 1961, Determination of the actual porosity of sandy-siltstone collectors based on the resistance of the flow zone: Prikladnaia geofizika (Appl. Geophysics), no. 30, p. 179-191. (R. A., p. 2770).

Belaenko, F. A., Gaek, IU. V., and Drukovanyi, M. F., 1961, Using high-speed motion-picture photography for studying by means of the photoelastic method the stresses occurring in solids during an explosion: Zhurnal nauchnoi i prikladnoi fotografii i kinematografii (Jour. Sci. Appl. Photography and Cinematography), v. 6, no. 4, p. 286-288. July-August. (R. A., p. 2763).

Belikov, B. P., 1961, Elastic properties of rocks: Akad. Nauk SSSR Izv. Ser. Geol., v. 26, no. 11, p. 34-41. November. (R. A., p. 2783).

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Berishvili, G. A., 1960, Results of experiments in studying the effective use of short-delay blasting: Akad. Nauk Gruzinskoi SSR, Tiflis. Institut gornogo dela. Trudy (Acad. Sci. Georgian S.S.R. Inst. of Mining. Trans.), no. 2, p. 215-227. (R. A., p. 2640).

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Bun'kov, A. M., 1958, Increasing the accuracy of determining the mean velocity from the intersection point of refraction hodographs: Akad. Nauk SSSR. Ural'skii filial, Sverdlovsk. Gorno-geologicheskii institut. Trudy (Acad. Sci. U.S.S.R. Ural Br. Mining Geol. Inst. Trans.), no. 34, p. 87-93. (R. A., p. 2791).

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Chel'tsov, V. I., 1961, Strength and texture of carbonate rocks in the Melekhovo-Fedotovo deposit: Akad. Nauk SSSR. Institut geologii rudnykh mestorozhdenii, petrografii, mineralogii i geokhimii. Trudy (Acad. Sci. U.S.S.R. Inst. of Geology of Ore Deposits, Petrology, Mineralogy, and Geochemistry. Trans.), no. 43, p. 25-32. (R. A., p. 2721).

Dadashev, A. M., 1961, Logging characteristics of the profile of the productive formation of the Kianizadag platform: Baku, Akad. Nauk Azerbaidzhanskoi SSR. Doklady (Acad. Sci. Azerbaijan S.S.R. Repts.), v. 17, no. 7, p. 589-594. (R. A., p. 2649).

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Frozen ground.

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