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schist facies of the Wissahickon Formation in the western part of the area are surprisingly magnetic and produce a belt of intense linear anomalies continuous for more than 300 km. These anomalies can be traced beneath the Culpeper Triassic basin and join anomalies coincident with the Evington Group near Dillwyn, Va. 3) Anomalies associated with metabasalts of the Catoctin Formation outline the Blue Ridge anticlinorium and can also be traced beneath the Culpeper basin. However, ground surveys and magnetic properties measurements show that the metabasalts are magnetic only in part and apparently a magnetic stratigraphy exists. 4) Precambrian gneisses of the Reading Prong are highly magnetic, in sharp contrast with nonmagnetic gneisses in the core of the Blue Ridge and indicate a fundamental difference between these two basement terranes.

Prospecting and Problems Associated with Geochemical Reconnaissance in Glaciated Terrain

D. W. Foss and *W. E. Scherffius*, North American Exploration, Inc., Charlottesville, Va.

Industry-sponsored exploration, for heavy metals generated the over 3000 sediment samples used for this investigation. The areas of consideration are now known to host one porphyry copper type ore body, two molybdenite prospects and several lead-zinc occurrences. Geographically situated in northwest central and central Maine, the area is underlain by a variety of rock types roughly grouped, for statistical purposes, as 1) quartz monzonite and related rocks, 2) basic intrusive rocks and 3) low-grade metasedimentary rocks. The metal distribution in stream sediments from varying bedrock types comprise part of this study and were used to outline anomalous heavy metal concentrations. Subsequent detailed geochemical and geophysical investigation of the anomalies generated by the sampling and to contend with the difficulties of permiability and varying depths of glacial debris. Significantly, sediment sampling may be more effective for defining bedrock anomalies than soil geochemistry, as exemplified by a bedrock lead-zinc prospect mantled by a transported copper-molybdenum anomaly in glacial till.

Heat Flow in Virginia

J. K. Costain, VPI, Blacksburg, Va. *

Seven sites are now available in Virginia where geothermal gradients have been determined and heat flow values estimated. The flux at Cripple Creek, Va. (36° 49′ N, 81° 06′ W) is 1.03 ± 0.15 μcal/cm^2-sec. In southwestern Virginia near Grundy (37° 20′ N, 82° W) the heat flow is 1.7 ± 0.34 μcal/cm^2-sec. The heat flow, uncorrected for climatic or terrain effects, on the Blue Ridge at Poor Mountain (37° 10′ N, 80° 10′ W) is 0.78 ± 0.08 μcal/cm^2-sec. Geothermal gradients in Bath County at 38° 14′ N, 79° 49′ W reach a maximum of about 15 °C/km and do not show the higher temperatures found at the Hot Springs area about 15 km to the south. The recently discovered linear relationship between surface heat flow and surface heat production suggests some applications of heat flow studies to solving major structural problems by identifying or confirming large areas of overthrust crystalline rocks. A locality now under investigation is in the southeastern United States where the Inner Piedmont may be entirely allocthonous. The heat flow at Poor Mountain implies that more than 20 km of crystalline rocks have been eroded from above the rocks now exposed at this locality in the Blue Ridge.

Open Pit Mining

9:00 AM **M&E**

Chairman: *T. E. Scartaccini*, Casa Grande, Ariz.

Open Pit Equipment Selection and Maintenance

F. H. Buchella, Jr., L. G. Dykers, B. E. Grant and *T. Jancic*, Duval Sierrita Corp., Sahuarita, Ariz.

Principal factors influencing equipment selection can be grouped into five basic categories. 1) Ore and waste tonnages largely determine the types of loading, transporting, and ground preparation equipment to be used. 2) Topographical features and property limits influence the location of processing plants and waste disposal areas. 3) Working conditions, space limitations, and ore tenor generally govern the selection of loading and ground preparation equipment. 4) Equipment selection is also influenced by physical properties of the ore and waste. 5) Extremes in temperature, rainfall, and/or snowfall may dictate the need of special features of types of equipment. The basis of equipment selection lies in reviewing equipment characteristics and capabilities along with the mining and the anticipated operating requirements and environmental conditions. A good maintenance program is vital to the success of any open-pit mining operation. Some factors essential for a good maintenance program are: a clear definition and understanding of organizational structure; written work orders; preventative maintenance; proper warehouse practices; systematic accumulation and record of maintenance data; careful planning and forecasting along with appropriate budgetary controls; planned equipment shutdowns, standard overhaul procedures, engineered work measurements; and finally, functionally designed and well equipped shop facilities. A good maintenance program supported by adequate facilities will maximize equipment availability and productivity, which in turn will result in safe, efficient, and low-cost mining.

Computerized Year by Year Open Pit Mine Scheduling

C. E. Williams, Asarco, Tucson, Ariz.

A computer program has been developed which will locate the economic limits of an open pit mine and also designate which ore and waste blocks to remove per period (years or quarters) which will maximize the discounted cash flow over the life of the mine. A carefully selected set of operating constraints will control the following functions: 1) The removal of overburden by preproduction and production stripping exposes a fixed amount of ore. 2) A constant manpower and equipment usage is insured (except for trucks). 3) The tons of mill ore, concentrate and stockpiled ore are regulated. 4) The number and extent of shovel moves are minimized. 5) The grindability of the rock is considered as well as the variable haulage cost caused by variable haulage distances and depths. 6) A working pit slope may be designated which is different than the ultimate slope. 7) The size of the shovel working area is regulated. As many as fifty alternate schedules can be produced per computer run. They are arranged in descending order starting with best solution. For each schedule the following reports are generated upon request: 1) A period-by-period mining schedule listing the tonnages of ore and waste removed per bench. 2) Bench composite maps showing the state of the mine at the end of each period. 3) Bench plan maps designating by contours the mining limits of each period at the end of mining. 4) A year by year financial outcome and rate of return calculation.

Further Experimenting with Tandem Axle Trucks

R. Winkle, Kennecott Copper Corp., Ray, Ariz.

Crushing and Grinding and Concentration

9:00 AM **MPD**

Chairman: *W. C. Hellyer*, Newmont Exploration Ltd. Danbury, Conn. and *A. D. Taylor*, Bechtel, San Francisco, Calif.

Comparative Evaluations of the Snyder Process

W. J. Cavanaugh, Lone Star Industries, Inc., Brookfield, Conn.

The Snyder Process is a method of comminuting materials by introducing the ore and a working medium such as air, gas, or steam, under pressure in a vessel and suddenly releasing the charge. The size reduction occurs through the entrainment of the ore in the compressible working fluid (steam, air, or other gases) and their subsequent acceleration to sonic and supersonic velocities. Interparticle collisions and other shock producing phenomena are responsible for the size reduction which takes place. The purpose of this paper is to describe some of the comparative evaluations that have been made of the process to various materials. The examples that are chosen are those in which parallel tests took place with conventional methods of comminution. These examples show comparative details of the comminution techniques and the subsequent beneficiation, and the differences in the resulting concentrate recoveries and grades. These examples in the paper demonstrate the metallurgical benefits to be derived from Snyder Processed material. These advantages are believed to be due primarily to improved liberation of minerals at coarse sizes, and in some cases, this is further demonstrated through the results of microscopic examination. The factors which cause the breakup of the material are outlined along with the continuing research program. In addition, the history and development of commercial prototypes is described in general terms. The laboratory facilities and the procedure followed in normal testing work and comparisons of four different sizes of Snyder Process Units are presented in this paper.

The Economics of Using a 10 Ft SYMONS Cone Crusher

A. P. Szaj, Nordberg Machinery Group of Rexnord Inc., Milwaukee, Wisc.

This paper will cover the history of the development of the 10 ft SYMONS cone crusher and the reasons why it evolved in the mining industry. The criteria for successful use of this super-sized crusher will be discussed covering such points as: 1) at what plant capacity does this crusher become economical, 2) how does a crusher of this size affect auxiliary equipment, 3) what is different about this crusher than other conventional crushers, and 4) what are the advantages and disadvantages of using a 10 ft crusher. Since this crusher will have an extremely high capacity, the author will also compare the use of this crusher in a conventional crushing-grinding circuit vs an autogenous mill circuit. Data on the general statistics of the crusher will also be covered by charts and general drawings.

Pebble Grinding at Bethlehem Copper Corp. Ltd.

C. W. Overton, J. W. Smith, and *E. A. Lowe*, Bethlehem Copper Corp., Ltd., Ashcroft, B.C., Canada

Bethlehem Copper Corp.'s rated plant capacity had been increased through a series of expansions from 3000 up to 12,000 short dry tons per day. With throughput averaging 15,500 short dry tons, recovery, because of insufficient liberation, was suffering and studies were initiated to improve recovery without reducing tonnage. Grinding and flotation tests demonstrated that an additional 0.44 lbs of copper could be recovered from each ton of ore by finer grinding. When estimates of operating costs for further reduction with steel balls indicated a poor return on investment, pebble milling was investigated as a lower operating cost alternative. A pilot scale test using pebbles screened from ore to grind a sample of our flotation feed from an 80% passing size of, say, 210 μ down to 115 μ gave encouraging results and estimates of operating costs indicated a recovery of investment in less than three years. After an 11-month construction period the mills were in operation and the job of evaluating operation to get the optimum results began. Within the two-month period it took to bring the two mills to routine operation, recovery increased from 82% up to 89%, plant capacity increased to 17,500 dry tpd, and copper production increased in excess of 20%.

To be presented by Concentration Committee
Title and author to be announced.

Title and author to be announced.