SPOTLIGHT

on sophisticated analytical equipment at Black Mountain

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The ore mined at Black Mountain is of a complex nature, being composed of both magnetic and massive sulphides, which have greatly varying metal values. Because of this, there is need for a rapid method of assaying for the continuous monitoring and control of the process streams, and the Outokompu Courier on-stream analysis system and the Proscon process-control computer systems have therefore been installed.

On-stream analysis

The heart of the control system is a facility provided by the Courier X-ray analyser, which every six minutes gives assays of copper, lead, zinc, silver, and iron, and the percentage solids in 14 slurries. A sample of each slurry is taken, pumped to the sampling section of the unit, and split to present a final portion to the X-ray analyser and to timed samplers, where a sample is taken for chemical analysis.

A moving head spectrometer unit analyses the samples in strict rotation or, depending on circumstances, as programmed. The spectrometer pauses in front of each sample that is contained behind a window in a test cell for a period of 20 seconds, and completes the inspection of 14 slurries plus two standardization routines within six minutes.

The measuring head contains an X-ray tube and separate scintillation detectors for each of the elements to be analysed, in addition to a backscatter channel for the determination of pulp density.

The measured X-ray values accumulated in each of the channels are fed to a PDP11/34 data-processing system to be converted into an accurate assay. This is achieved by the processing of the X-ray results according to a specially prepared mathematical model that compensates for the inter-elemental and other matrix effects inherent in the X-ray-fluorescence technique. The model also compensates for mineral composition, pulp density, and particle size.

The calculated data are fed to a computer system, recorders, alarm annunciators, and heavy-duty report typewriters. The print-out provides periodic, shift, and daily reports.

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Process Control

The operation of the Courier system is thus complemented by the Outokompu Proscon process-control computer system permitting greater metallurgical effi ciencies to be achieved at Black Mountain than would have been possible without such control.

The Proscon system comprises the 103, which is a stabilization system, and the 105, an optimization system. The Proscon 103 can operate independently of the 105 and operates in real time, while the 105 operates on a time-sharing basis.

To achieve stabilization, the Proscon 103 is interfaced with the Courier analyser and the process instrumentation. It both monitors and controls such parameters as ore feed, water addition, reagent dosing, and flotation-cell air and level. The number of variables displayed is 187, with 93 altered manually from the control console and 18 under full computer control.

The process operator communicates with the system through a control console specially designed to avoid confusion. Each loop has its own control module, and is clearly marked to indicate the process function it performs rather than a code, thus reducing the possibility of operator errors. The modular concept allows any loop to be operated either under manual or computer control, thus allowing complete manual control from the console if required.

Communication is carried out with the PDP11/34 computer in a conversational manner through a CRT display unit, thus allowing loops to be added or modified on-line without shutting down the process. The CRT and a teletype also serve as a means of reporting.

Proscon 105 also utilizes a PDP11/34 in conjunction with RK06 discs and RX11 floppy-disc drives. The system provides long-term reporting and management summaries, process performance studies, and general technical and economic calculations, and optimizes control to achieve maximun economic returns.

Progress at Black Mountain

As with all new plants, many mechanical and metallurgical problems had to be overcome, which delayed the setting up of control equipment and loops. After four months, control was possible and was being carried out through the control-room console. Operators, after assessing what control action was required, would

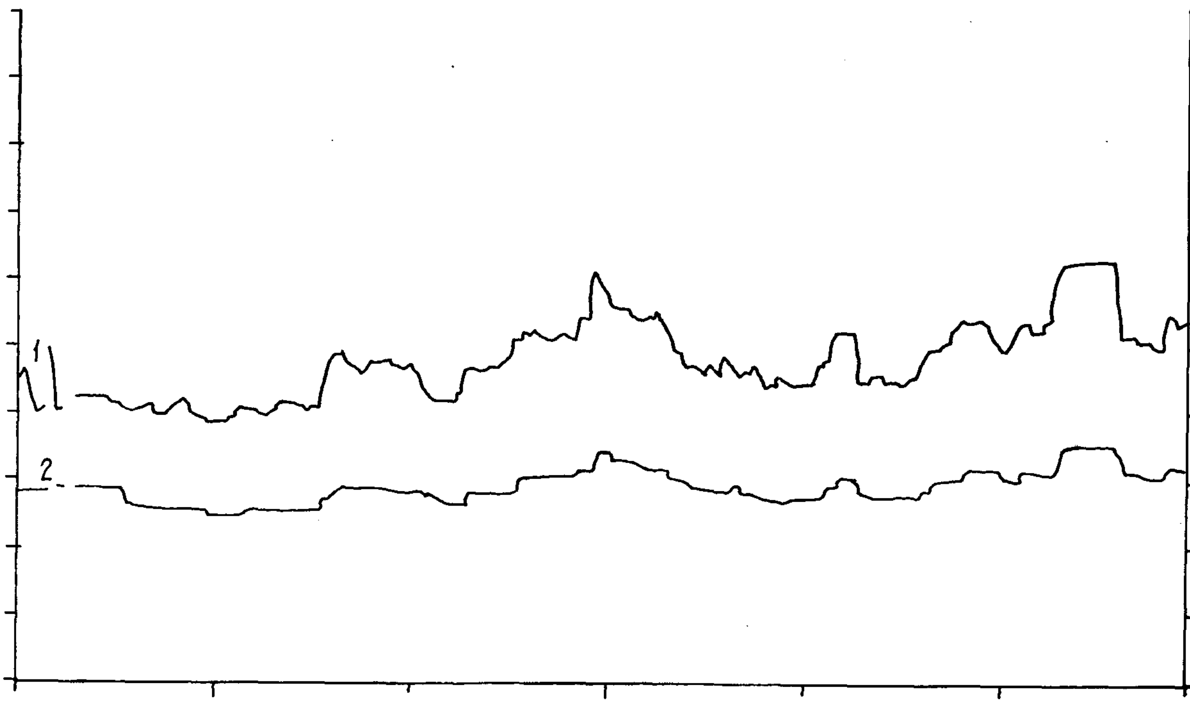

Fig. 1—Controlled addition of collector to the zinc conditioner
Curve 1: Zinc in zinc feed, %
Curve 2: Z—200 added to zinc conditioner

radio the central control room to alter the cell level, reagent flow, or whatever was needed.

The setting up of the on-stream analyser has been a lengthy business, with all the initial problems associated with the pumping of 200 l/min streams from the depth of the plant to the analyser sampling unit, and returning them to the parent streams. Only once this 'plumbing' had been sorted out could calibration begin. Also, the mathematical models can effectively handle only fairly small variations (within 15 per cent relative) in metal contents around the normal operating mean. In a new plant with inexperienced operators, the metal contents varied outside these limits, thus delaying the implementation of control loops. Table I shows the current status of the Courier calibration.

TABLE I
COURIER ANALYSER, NOVEMBER 1980
(ANALYSING FOR COPPER, LEAD, ZINC, SILVER, IRON, SOLIDS)

Circuit	Stream	Operating	Fully calibrated
Copper	Cyclone overflow	Yes	Yes
	Rougher concentrate	Yes	Yes
	Rougher tailing	No	No
	Rougher scavenger concentrate	Yes	Yes
	Final tailing	Yes	No
	Cleaner scavenger tailing	Yes	No
	Final concentrate	Yes	Yes
Lead	Rougher concentrate	Yes	Yes
	Final tailing	Yes	Yes
	Cleaner tailing	Yes	No
	Final concentrate	Yes	Yes
Zinc	Rougher concentrate	Yes	Yes
	Final tailing	Yes	Yes
	Final concentrate	Yes	Yes

TABLE II
CONTROL LOOPS, NOVEMBER 1980

Measured variable	Controlled variable
1. % Cu in cyclone overflow	Z-200 to rod mill
2. % Cu in cyclone overflow	Z-200 to Cu conditioner
3. % Pb in cyclone overflow	SEX to Pb conditioner
4. % Pb in cyclone overflow	R242 to Pb conditioner
5. % Zn in cyclone overflow	$ZnSO_4$ to rod mill
6. % Zn in Pb final tailing	Z-200 to Zn conditioner
7. % Zn in Pb final tailing	$CuSO_4$ to Zn conditioner
8. % Pb in Pb rougher concentrate	Pb rougher air valves Pb 1st cleaner air valves
9. % Pb in final concentrate	2nd cleaner air valves
10. % Zn in Zn final concentrate	3rd cleaner air vlaves Zn 1st cleaner air valves 2nd cleaner air valves 3rd cleaner air valves

Some of the selected data presented via the control console and on-stream analyser system are now being displayed via typewriters in the control room.

Once the analytical results became available, a start was made on the tuning of the control loops. The loops now in operation are given in Table II, which shows that 10 of the 18 designed loops have been completed. Fig. 1 shows the controlled addition of collector to the zinc conditioner for two of these loops, and Fig. 2 shows the value of lead in the lead concentrate being kept constant by the alteration of air to the different cleaning stages.

As would be expected, the 105 has not yet been used for optimization. However, its data collection and graphical reporting have been used in the evaluation of process conditions. The graphs displayed in Figs. 1 and 2 were generated through the 105 system with no manual

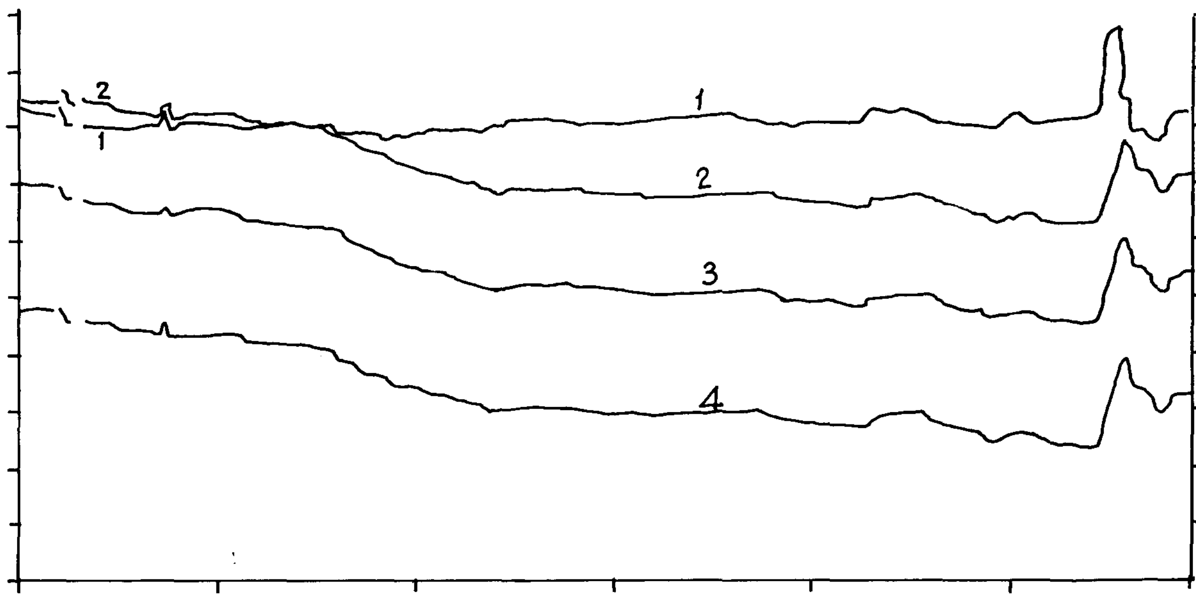

Fig. 2—Control of air to the cleaning stages

Curve 1: Lead in final concentrate, %
Curve 2: Air to the 1st lead cleaner
Curve 3: Air to the 2nd lead cleaner
Curve 4: Air to the 3rd lead cleaner

collection or plotting of data. Use is made of the linear regression package in the study of the process, and courier calibration models are generated by the 105 and transferred to the Courier computer. The computer facilities are also used for many calculating routines.

A characteristic of the Black Mountain start-up has been the willingness of all the staff to use this elaborate instrumentation, and to make use of the data it produces. The flotation process is very complex, involving a large number of parameters. Control of these parameters and recognition of process disturbances through on-stream analyses and the control systems have contributed substantially to the speed with which good metallurgical results have been achieved at Black Mountain. An unforseen benefit has been the increased process knowledge acquired by the operators during the control-loop tuning stage, when they were called upon to observe and report back on process disturbances that affected control.

Although the implementation of the process monitoring and control is still in progress, substantial benefits are already evident.

Geostatistics

In view of the continuing demand, the Department of Mining and Mineral Sciences in association with Special Courses Division, Department of Adult Education and Extramural Studies, both of the University of Leeds, will offer two further courses on A Practical Introduction to Geostatistics in 1981, each covering ten working days. The courses will run from 30th March to 10th April and 14th to 25th September.

As the title indicates, the course is intended to be a practical introduction to the study of geostatistics. Practical exercises taken from real situations will be used to introduce or reinforce the theoretical background of the subject.

The course is designed for engineers and geologists concerned with the valuation of mineral deposits and stoping blocks, and a minimum mathematical background is assumed. As far as possible, the approach to the subject is via geology and familiar practical situations, and the mathematical content is introduced in this manner. However, it will be helpful both to course members and lecturers if members do some recommended reading beforehand.

During the second week of the course further practical work and exercises will be done to reinforce the work of the first week. Members are encouraged to bring their own data for ore-bodies in which they are interested. In this case, the data should either be on computer cards, or ready to be punched onto cards. Anyone contemplating using this facility is advised to write to Mr A. G. Royle, who will advise on the format required for the data cards, and whether the jobs are suitable for the time allowed. This preliminary check is essential as there is little time on the course for getting data into a suitable format for card punching, and the data set should be of adequate size for the task. A data set comprising the co-ordinates and assays at 300 sampling points, set on a regular grid if possible, is the optimum.

Every member is recommended at least to have a try at producing a semi-variogram for an ore-body with which he is concerned, as this should form the basis for much valuable practical work on returning to his company.

Further information is available from the Director of Special Courses, Department of Adult Education and Extramural Studies, The University, Leeds LS2 9JT, England.