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MINES BRANCH

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THE MINERAGRAPHIC LABORATORY

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THE MINERAGRAPHIC LABORATORY

By

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A mineragraphic Laboratory has been added to the equipment of the Ore Dressing and Metallurgical Laboratories of the Mines Branch. This new equipment for the microscopic and spectroscopic examination of ore samples and mill products of ores under test is described for the information of those engaged in the mining industry.

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Introduction

Microscopic examination and spectrographic analysis have been found to be of immense value as a guide and an aid in investigating methods for the treatment of ores. The examination of typical samples of ore under the microscope, before concentration or other treatment experimental tests are undertaken, gives the investigator information in advance regarding the mineral constituents, their relationships and grain size. The determination of the minerals, coupled with the spectrographic analysis of the ore sample submitted to the chemical laboratory for quantitative determination, provides the chemist with virtually a complete qualitative guide. With the results of the microscopic examination and the chemical analysis before him, the investigator is enabled to conduct the investigation with a minimum number of experimental tests.

Quantitative microscopic determination carried out on the mill products furnishes the investigator with further information concerning the grain size of the products, their relationships, and the percentages of freed and locked minerals, the relative proportions of the valuable and valueless constituents, the shape of the mineral grains and the degree of surface oxidation

and corrosion. This information is especially valuable when the examination is performed on the various fractions from screen and elutriation tests of the mill products, as it assists the investigator in the control of the grinding and in determining the manner of re-treating the middling products.

Spectrographic analysis too plays an important part during the investigation. Precipitates and solutions obtained in the chemical laboratory during quantitative separations are identified or examined for their purity, and assays are checked for the presence of metals other than those expected, as for example, those belonging to the platinum group. In addition, because spectrographic methods are particularly applicable to the detection of minute quantities of minor constituents which defy detection by ordinary chemical methods, the presence of elements which may interfere either in certain of the experimental tests or in the chemical analysis may be revealed. And for the same reason the spectrograph is of great value in determining the mode of occurrence of the precious metals, such as gold in pyrite or arsenopyrite, or silver in galena and tetrahedrite.

The examination of ores and mill products both microscopically and spectrographically thus serves not only to reduce the number of experimental tests to be made in the Ore Dressing Laboratory, but also provides a valuable qualitative guide to quantitative chemical analysis. Furthermore, additional weight is lent to the results of experimental tests when they are supported by the convincing evidence obtained by a thorough microscopic

examination of the ores and mill products, and the inclusion of photomicrographs in the report presents this evidence in a concrete manner.

In carrying out microscopic and spectrographic studies in the Mineragraphic Laboratory, the sample is first mounted in bakelite and polished. The polished section is then examined under the reflecting microscope, and optical, etching, microchemical, spectrographic and quantitative-microscopic methods are combined in determining the characteristics. Photomicrographs are taken to illustrate the significant features of both the ore and mill products, and the polished sections representing the typical samples are filed for future reference. A report is rendered for each ore studied; this report, while primarily for the use of the investigator carrying out the experimental tests, is also available to those who are interested.

The following description of the equipment of the Mineragraphic Laboratory and the methods of its use will, therefore, be of more than general interest to the many already familiar with the nature of the work undertaken in the laboratories of the Ore Dressing and Metallurgical Division of the Mines Branch.

Description of the Equipment

Equipment for Preparing Specimens for Examination

Rough Grinding Unit:

The rough grinding unit consists of an iron-framed table in which are set two revolving 16-inch laps. The first lap

is of cast iron and, using No.120 carborundum as the abrasive medium, and is used for grinding the specimen to the desired shape and size. The second lap is of copper and with No. FFF carborundum produces a smooth matte surface and eliminates the larger pits developed during the first grinding. After completion of the rough grinding process the specimen is ready for mounting. In order to avoid the use of coarse abrasives near the microscopic equipment the grinding unit is located in the main Ore Dressing Laboratory.

Mounting Unit:

This unit comprises a mould and a press. The mould was made in the Department of Mines' machine shop, the design being adopted with slight modifications from that developed in the Laboratory of Mining Geology of Harvard University. Four specimens are mounted in one operation, the finished mount being a block of bakelite, 1½" x 1 1/8" x 13/16" in which the sample is embedded.

The press is a small hydraulic laboratory press manufactured by Fred S. Carver, New York. It has a capacity of 20,000 pounds and is equipped with electrically heated plates. A moulding temperature of from 150°C. to 160°C. is ordinarily used, at a pressure of 4,000 pounds per mount.

Polishing Units:

Two polishing units are installed in the laboratory. The first unit is a type similar to that widely used for polishing ore specimens, and consists of a ½ h.p., 1200 r.p.m. electric

motor, the shaft of which extends on both sides and is fitted with two 9-inch fibre discs covered with canvas, linen or billiard cloth. The polishing is carried out by hand with a mixture of abrasive and water. The average time required per specimen is about 15 minutes.

The second polishing unit was manufactured by the Mann Instrument Company of Cambridge, Massachusetts. The design of this machine was developed in the Laboratory of Mining Geology of Harvard University under the direction of Professor L.C.Graton, and the principle departs radically from that commonly employed in that the complete polishing process is carried out on metal laps. The machine consists of a revolving table with interchangeable cast iron and lead laps. The specimens, six in number, are held on the laps by means of a revolving head which also rotates the specimens by means of a planetary gear. The polish produced is far superior to that obtained by any other known method, and the machine has the distinct advantage of automatic operation. The average time required per specimen is about $1\frac{3}{4}$ hours.

Equipment and supplies are kept on hand for impregnating porous and friable specimens with bakelite varnish, preparing and mounting thin sections, and for mounting mill products for examination in unpolished state for surface features, etc.

Equipment for the Microscopical Examination of Prepared Specimens.

The Ore Microscope:

The microscope used for the examination of polished

surfaces is a model MOP ore microscope manufactured by E. Leitz of Wetzler, Germany. Equipped for use with polarized light and with an adequate supply of air and oil immersion objectives, it provides for a range in magnification from 30 to 2200 diameters. Other attachments include a traversing stage, a Wright bi-quartz wedge attachment and a Leitz "Ultropak" illuminator, the last being used for examining finely ground mill products in diffused oblique light. The light source is a low-voltage, high-amperage lamp, which produces illumination sufficiently intense for the use of polarized light.

The polished section is first examined for the purpose of identifying the mineral constituents. After this has been accomplished as far as is possible by the use of optical, etch, microchemical and spectrographic methods, the relationships of the minerals are recorded.

The Micro-borer:

Samples of mineral grains for microchemical and spectrographic tests are obtained from the polished surface by means of the micro-borer. At first designed and roughly constructed in the Department of Geology, Princeton University, a second improved instrument was designed in this laboratory and built in the Department of Mines' machine shop. It consists of an adjustable brass stand that supports an ordinary sewing needle rotated by means of a flexible shaft driven by a small, variable speed, electric motor. The mineral grain is brought into contact with the needle point by raising the stage of the microscope.

The Petrographic Microscope:

For certain investigatory tests it is important that the nature and identity of the gangue minerals be determined, particularly for their bearing on crushing and flotation problems. Polished sections do not lend themselves readily to the determination of transparent minerals, and for this reason it is necessary to prepare a thin section and examine it under a petrographic microscope. The petrographic microscope used in this laboratory is a Seibert. It is used also in microchemical analyses for observing the precipitates in transmitted light.

Equipment for Spectrographic Analysis:

Although spectrographic methods are used for approximate quantitative analysis, it is in the field of qualitative analysis where the spectrograph is of greatest use in this laboratory. It is particularly sensitive in detecting the metals, especially when these are present in minute quantities. The spectrograph is used in the Mineragraphic Laboratory for the determination of:-

1. The elements in minerals present in minute grains and which provide only a very small sample.
2. The valuable metals in minerals.
3. The elements in ore samples, to serve as a control for quantitative chemical analysis.
4. The minor constituents in ore samples, and in minerals and for checking.
5. Chemical precipitates for purity and identification.
6. Assays for the presence of small amounts of metals such as those of the platinum group.

The Quartz Spectrograph:

The quartz spectrograph is the medium-sized instrument manufactured by Adam Hilger, London, England.

Motor-Generator Unit:

The motor-generator unit was manufactured by the Lancashire Dynamo and Motor Company of Canada. It was designed especially for producing a direct-current arc for use in spectrography. The unit consists of a motor, generator, and exciter, and is capable of a range in voltage from 100 V to 250 V at a maximum current of 10 amperes. The current is controlled through a switch board.

Spark-Unit:

The spark unit was furnished by the makers of the quartz spectrograph and is the standard equipment for producing spark spectra. The control of this unit is also located on the main switch board.

Viewing Table:

The photographic plates on which the spectra are recorded are examined under a binocular microscope. The table, designed and built in the Department of Mines' machine shop, differs from the ordinary microscope table only in being provided with a slit through which light from incandescent bulbs can be thrown from below through the plate. In certain cases where the spectra are exceedingly complicated and the lines closely grouped on the plate, the image is projected on a screen by means of a balopticon and the analysis made on the greatly enlarged image.

Equipment for Photomicrography:

Metallographic Microscope:

The large metallographic microscope is of Leitz manufacture and so is adapted for all the oculars and objectives used on the ore microscope as well as the "Ultropak" illuminator. The range of magnification with various optical combinations is from 25 to approximately 12,000 diameters.

Photomicrographic Camera:

This camera is used in combination with either the ore microscope or the petrographic microscope, particularly when photographs of polished sections in polarized light or of thin sections are desired. The instrument is of Leitz manufacture and has a range in magnification of from 25 to over 2000 diameters.

Equipment for Filing Specimens and Photographs:

Filing space in especially designed cabinets is provided for 3500 polished sections, 1000 photomicrographs and 800 spectrograph plates. Card indexes of sections and plates in conjunction with the field specimens provide a complete and permanent record of the work done in the laboratory.