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A MOBILE CHEMICAL LABORATORY FOR TRACE-ELEMENT ANALYSIS

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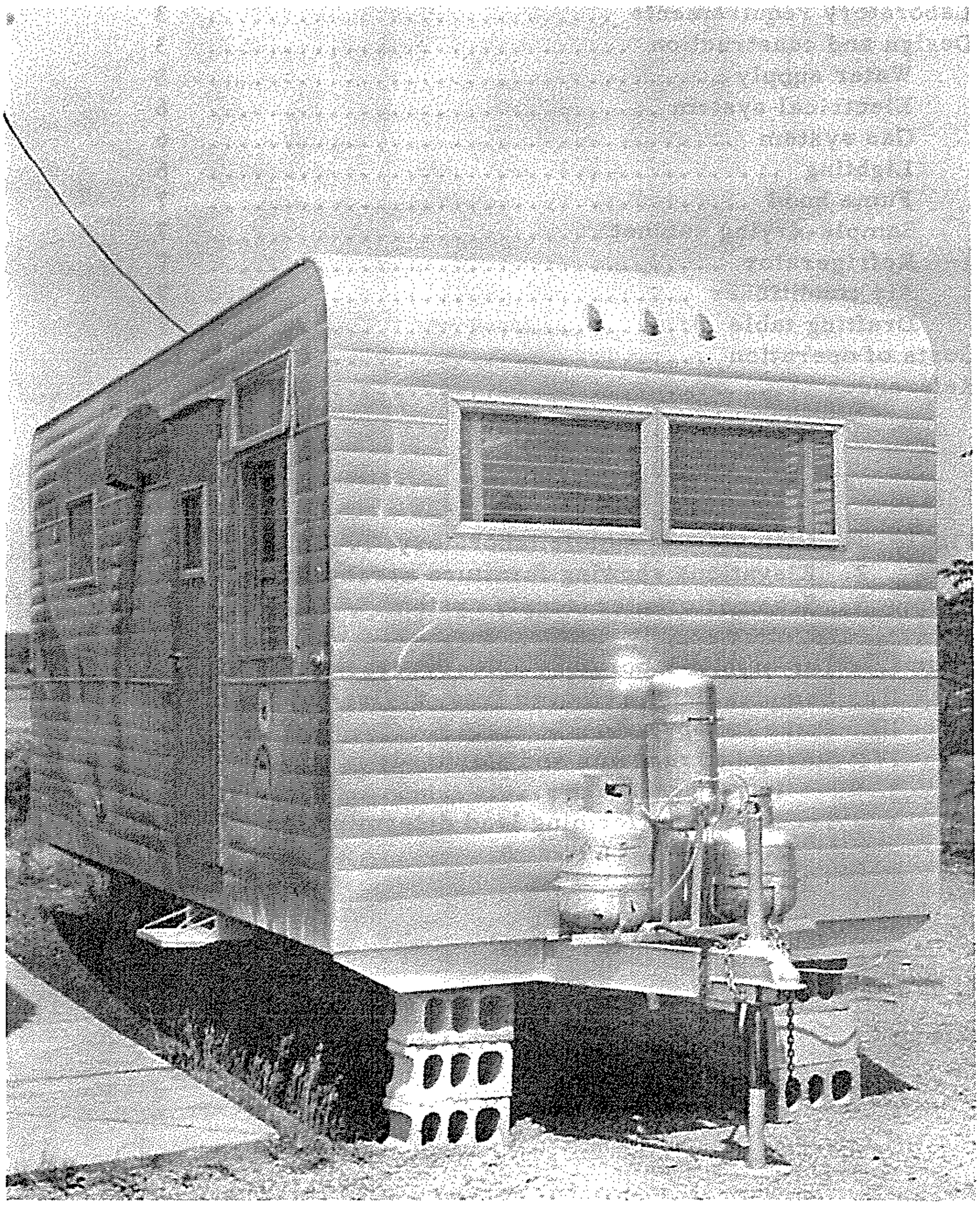

Plate I. The mobile laboratory.

A MOBILE CHEMICAL LABORATORY FOR TRACE-ELEMENT ANALYSIS

Introduction

In 1956 the Geological Survey of Canada began a program of regional geochemical surveys of the heavy-metal content of stream sediments on the mainland of Nova Scotia. This program has been continued annually, and has been extended into southeastern New Brunswick. The results have been reported by Boyle et al. (1958)*, Holman (1958), and Smith (1960).

In the initial survey in 1956, analyses of stream-sediment material were done by quick methods either at the sampling site or in a temporary base laboratory. The analytical procedures were those of Bloom (1955) and Holman (1956). Commencing in 1957, reference samples of all sediments collected were sent for a more accurate analysis to the laboratories of the Geological Survey in Ottawa. The methods used were those described by Gilbert (1959). These procedures, involving hot sample attack, required more complete analytical facilities than were available in temporary field laboratories, but proved to be much more sensitive and reliable.

The large number of samples taken in a regional program necessitated the allotment of much time for their analysis in the Ottawa laboratories. Additional technicians were required for the handling of these samples, and the full time of a skilled analyst was necessary to supervise the work. There was often a considerable delay between collection of the samples and forwarding of the results to the field parties, so that any possibility of using the results to guide further work was lost in many cases. Accordingly, when Smith began the regional geochemical sampling program in southeastern New Brunswick, it was decided to develop a mobile chemical laboratory equipped with facilities for trace-element analysis of stream sediments, soils, waters, rocks, and plants, as might be required in future programs. When design of the laboratory was begun, little or no helpful information could be found in the literature. This paper describes the resulting laboratory and its use under field conditions. It is hoped that this information will be helpful to others contemplating the operation of such a laboratory.

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*Dates in parentheses are those of publications listed in the References.

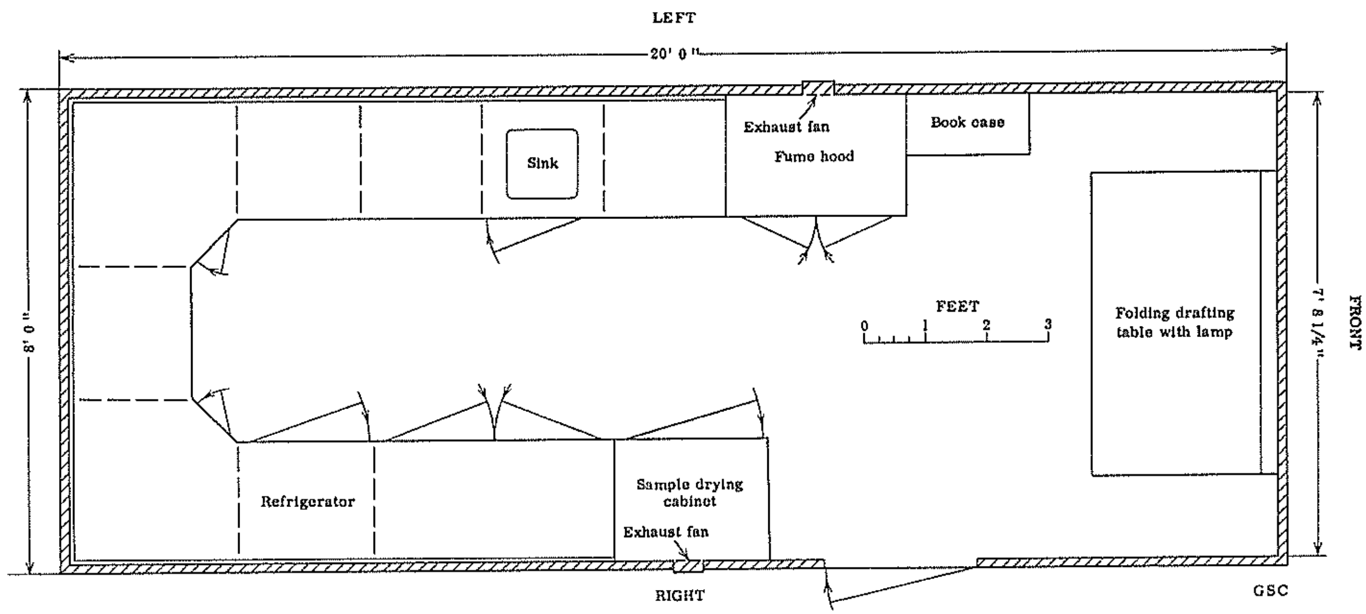


Figure 1. Plan view of mobile chemical laboratory

Laboratory Requirements

Considering that the sampling program might involve the taking of up to one hundred samples of soils, stream sediments, or rocks per day, the laboratory was required to meet the following needs: facilities for drying the stream-sediment samples, and a fume hood for hot fusion or acid extraction procedures; adequate bench space for the chemical procedures, in addition to storage space for glassware, chemicals, balances, and other instruments; continuous supplies of metal-free water, essential in trace-element work; and refrigeration facilities for storing heat- and light-sensitive reagents and standards.

As two men would be required to carry out the analyses, the working area had to be sufficiently large to permit freedom of movement. Sample preparation was to be done outside the laboratory in as many cases as possible, thus making available more space within the laboratory and decreasing the risk of contamination.

The decision to house the mobile laboratory in a trailer body, rather than in a truck, was based on several factors. The use of a trailer, which could be towed to the point of operations and parked, would provide greater flexibility. The laboratory would not be moved more than once or twice during a field season, and the towing vehicle would be available for sampling operations. Levelling a trailer is far easier than levelling a truck-mounted unit. Finally, initial and operating costs (and depreciation) favoured a trailer-type unit.

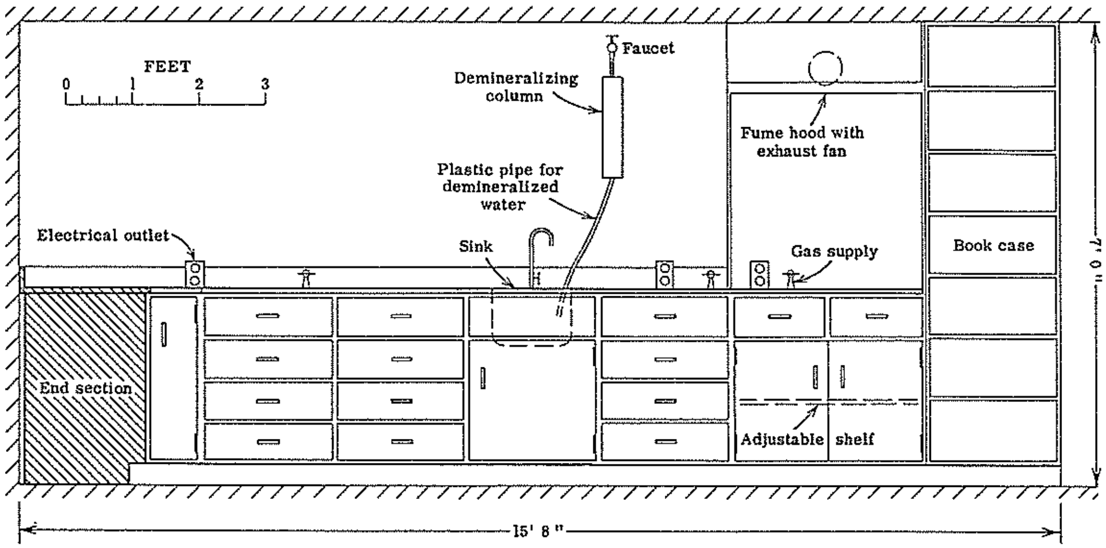
Design and Construction

The laboratory is installed in a standard industrial-type trailer, 20 by 8 feet, with an inside height of 7 feet. Inside walls are of 3/16-inch birch plywood and walls and ceiling are insulated with 2-inch mineral-wool bats. The floor is finished in battleship linoleum, and insulated with 6 inches of mineral wool.

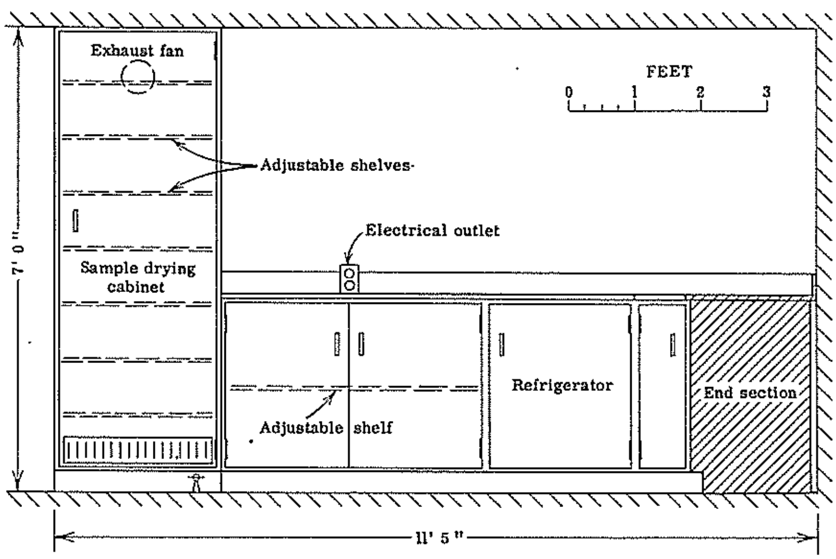
The laboratory furniture is of the standard type, made of 3/4-inch birch with 3/4-inch arborite tops. The fume hood, sample-drying cabinet, and drafting table are of special design. These facilities, as well as the conventional services, including gas, water, lighting, electricity, refrigerator, and air conditioning, are described in detail below. The design of the laboratory is shown in Figures 1 and 2.

Water Supply

Water is supplied to the laboratory in two separate systems. Raw water for general washing is supplied to a tap at the sink from a 30-gallon steel tank mounted below the trailer. A second 20-gallon steel tank carries distilled water. This comes through plastic pipe to tap mounted on the wall above the sink. The water passes



LEFT SIDE ELEVATION



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RIGHT SIDE ELEVATION

Figure 2. Diagram showing interior side elevations, mobile chemical laboratory

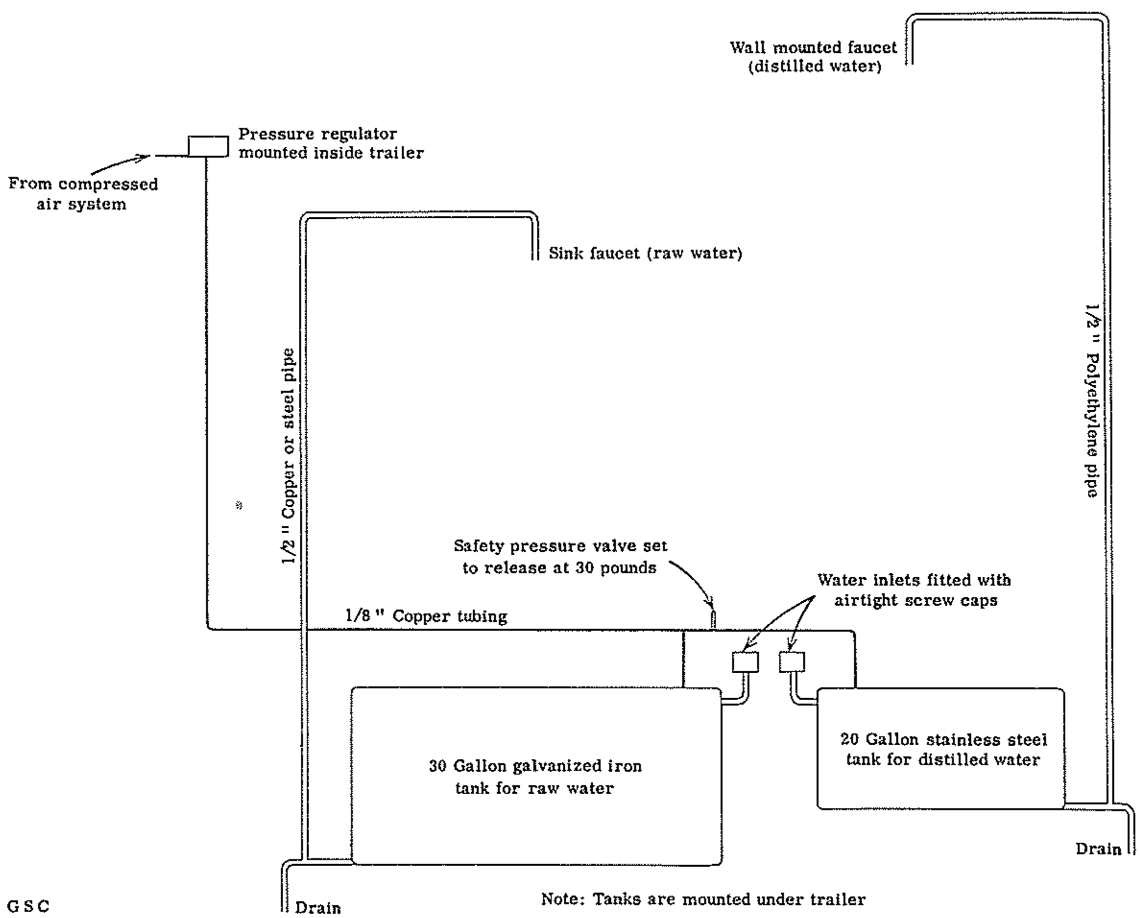

Figure 3. Diagrammatic sketch of the water system designed to operate on compressed air

through a mixed resin ion-exchange column, providing a continuous supply of metal-free water. Distilled water is preferred because it prolongs the life of the resin column, but if it is not available, rain water or soft metal-free spring water may be substituted.

Pressure in the water system was provided initially from commerical compressed-air bottles. However, this was found to be expensive because of small leaks in the air system. In its place, a small air compressor of the paint-spray type was substituted. The operation of this compressor for two or three minutes twice a day is sufficient to keep a continuous pressure.

A pressure-regulated switch would permit automatic maintenance of a constant pressure in the water system, and could also be used to provide a supply of compressed air in the laboratory. This has not been considered necessary or desirable in the present installation.

Electrical System

The laboratory is wired for 100-ampere, 110-volt, 60-cycle service, through nine fused circuits. Each bench-mounted receptacle box is on a separate 15-ampere circuit, as are the lights and fans. The air conditioner is on a separate 20-ampere fused circuit. The large number of circuits permits the use of specialized equipment, which may have rather heavy power requirements. At present the laboratory is supplied with power from the local power company, but if necessary it could be supplied from a portable generator.

Gas System

Gas is provided to the laboratory from two 20-pound bottles of propane, mounted on the hitch at the front of the trailer. Three deck-mounted laboratory gas-cocks are placed along the left bench and in the fume hood. One additional gas outlet is situated in the sample-drying cabinet for the operation of a small gas heater. Gas consumption averages one 20-pound bottle per week.

Lighting

Three double 40-watt-tube fluorescent fixtures light the work benches. A fourth fixture lights the central area of the laboratory. The drafting table at the front of the laboratory is lighted by a flexible fluorescent desk lamp. There are sufficient windows in the laboratory so that electric lights are only needed on dull days or in the evenings.

Fume Hood

A stainless-steel fume canopy is used instead of the conventional fume hood, which is too heavy for a laboratory of this type. Fumes are exhausted by a small kitchen-type fan; this has been found adequate for the extraction procedures now followed, although a larger, more powerful fan would be desirable. If necessary, the fume canopy can be fitted with plexiglass front and sides, converting it into a conventional fume hood.

Sample-Drying Cabinet

Stream-sediment samples are dried in a special cabinet with double steel walls separated by 1 inch of glass-wool insulation. Air is drawn into the cabinet through louvers in the door, is heated by a small gas burner mounted on the floor, passes over the wet samples placed on steel racks in the cabinet, and is exhausted to the outside by a large kitchen-type fan. The fan is fitted with a three-position switch which controls the temperature satisfactorily. Temperatures of more than 100°C are possible, but 60 - 70°C has been found adequate for drying.

Refrigerator

The laboratory is fitted with 4.5-cubic-foot refrigerator mounted under the work bench. This item is indispensable in trace-element analyses in which organic reagents are used. Working solutions of dithizone in carbon tetrachloride (0.001 per cent W/V) can be kept in the refrigerator for more than a week without loss of strength, and prepared standards are much more stable when kept in the refrigerator.

Air Conditioner

Without some form of air conditioning it would be impossible to work in a laboratory of this type on hot days. The present installation, an air conditioner of 6,000 Btu capacity, is not quite adequate under certain conditions. With the sample—drying cabinet in operation, and with a burner or hot plate operating in the fume hood, a unit of larger capacity would be desirable. In addition, the air conditioner should be fitted with a dehumidifier, because on humid days, cold test tubes taken from the refrigerator condense considerable moisture, making it difficult to read the standards.

Drafting Table

The laboratory has been fitted with a drafting table on the front wall, which can be folded down when the unit is being moved. In the geochemical surveys for which the laboratory was designed, the drafting table is useful, although it sometimes becomes a collecting centre for all manner of equipment, papers, etc. Perhaps this space might be put to better use as additional bench space, keeping the entire unit to a single function.

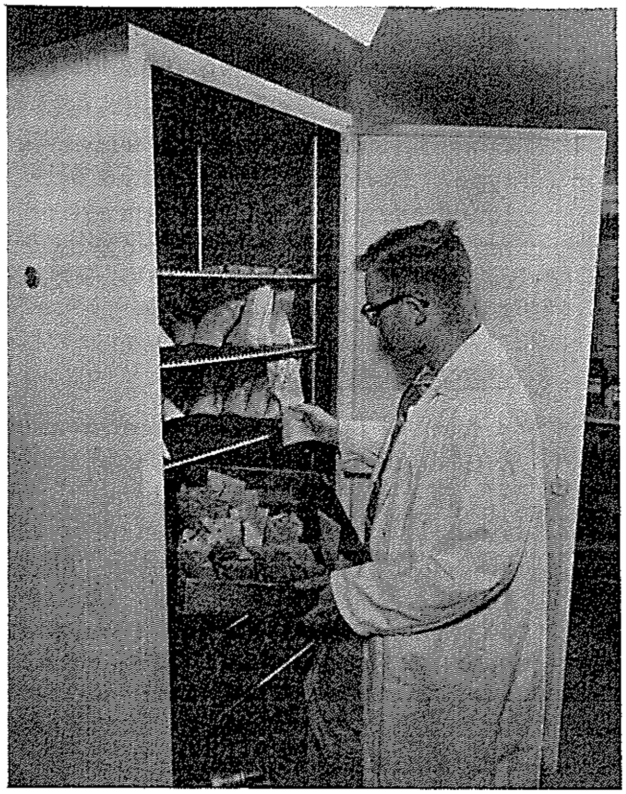

Plate II.
Dried stream-sediment samples being removed from the sample-drying cabinet.

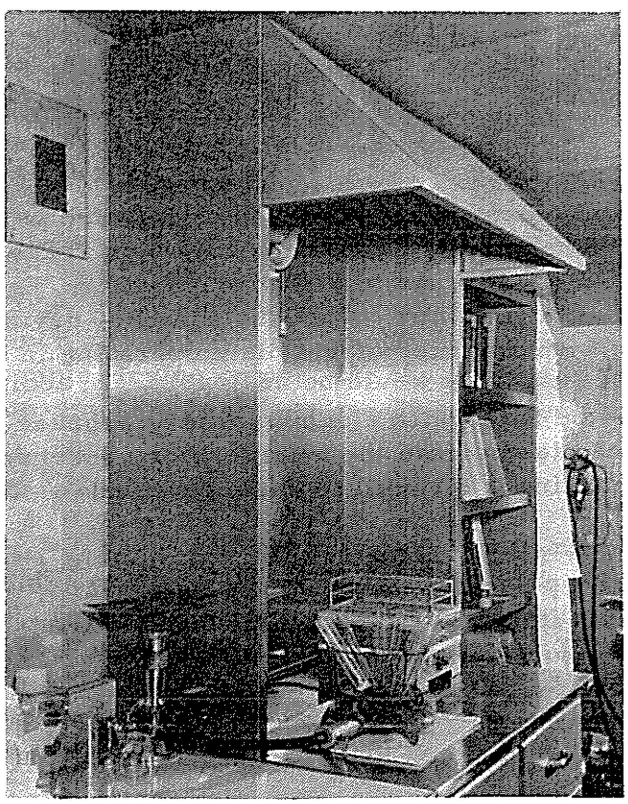

Plate III.
Fume canopy, showing fusion burner and hot plate.

Plate IV. Heat- and light-sensitive reagents and standards are stored in the laboratory refrigerator.

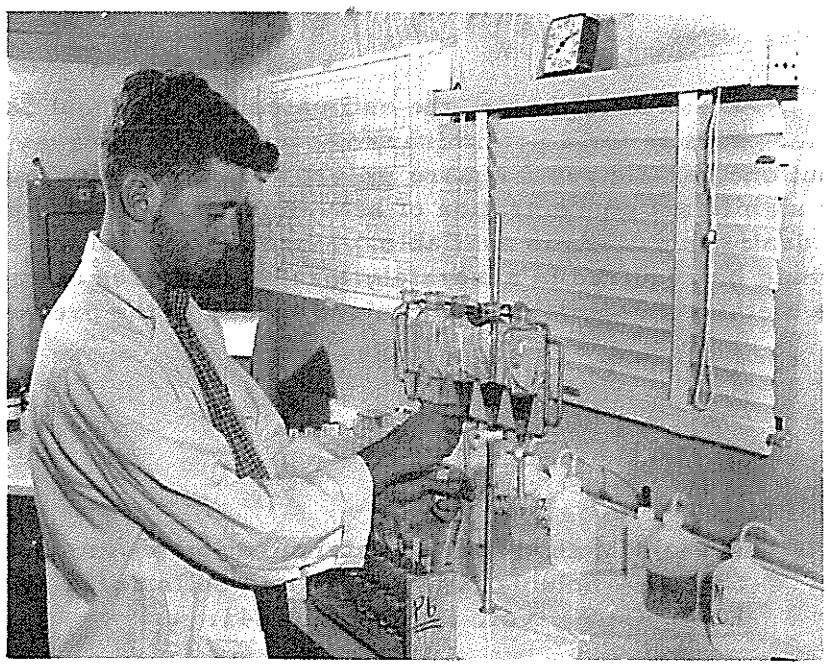

Plate V. Technician performing routine lead determinations in the mobile laboratory.

Costs of Operation

Although the laboratory was first used in the summer of 1960, the field program that year was on a reduced scale, so that it was not until 1961 that a full estimate of its usefulness and efficiency could be made. The following estimate of approximate costs, based on the 1961 operation, may serve as a guide to people interested in reconnaissance geochemical programs.

The field party consisted of the supervisor (Smith), two men sampling stream sediments in the field, one man preparing samples for analysis, and one man performing analyses. Approximately 2,000 samples were collected over an area of some 4,000 square miles. Analyses were performed for copper, lead, and zinc.

The estimated cost per sample—this includes wages, sampling costs (including operation of vehicles), chemicals, and 10%-per-annum depreciation on the initial cost of the laboratory—is about $5, or $1.60 per determination. Of this amount, about 40 cents per sample (15 cents per determination) represents the cost of chemicals and depreciation of the laboratory; about $1.20 per sample (40 cents per determination) represents labour cost for two analysts; and the remainder, approximately $3.40 per sample ($1.05 per determination), is the cost of collecting the samples, including labour, operation of vehicles, etc.

On an areal basis, the estimated cost is about $2.50 per square mile. This is for a preliminary reconnaissance survey only, taking about one sample per 2 square miles; such a survey should detect any significant concentration of heavy metals, provided a well-developed drainage pattern is available. More detailed surveys, of course, would be required to accurately locate the source of any anomolous metal-concentrations that might appear in the preliminary survey.

References

Bloom, H.
1955: A Field Method for the Determination of Ammonium Citrate - Soluble Heavy Metals in Soils and Alluvium; Econ. Geol., vol. 50, pp. 533-541.

Boyle, R.W. et al.
1958: Heavy Metal (Zn, Cu, Pb) Content of Water and Sediments in the Streams, Rivers, and Lakes of Southwestern Nova Scotia; Geol. Surv., Canada, Paper 58-1.

Gilbert, M. A.
1959: Field and Laboratory Methods Used by the Geological Survey of Canada in Geochemical Surveys. No. 1, Laboratory Methods for Determining Copper, Zinc and Lead; Geol. Surv., Canada, Paper 59-3.

Holman, R. H. C.
1956: A Method for Determining Readily Soluble Copper in Soil and Alluvium—Introducing White Spirit as a Solvent for Dithizone; Trans. Can. Inst. Mining Met., vol. 66, pt. 1, pp. 7-16.

1958: Heavy Metals in Stream Sediments, Northern Mainland of Nova Scotia; Geol. Surv., Canada, Map [illegible]-1958, sheets 1 and 2.

Smith, A. Y.
1960: Heavy Metal (Zn, Cu, Pb) Content of Stream Sediments of part of Westmorland County, New Brunswick; Geol. Surv., Canada, Paper 59-12.