all the deposits claimed on this side of the railroad. On the other is a mound about 15 feet high, and extending 100 feet perpendicular to and 70 along the track. Both of these are evidently of ore-bearing rock. Beyond the mound on the north side of the track, across a marsh about 100 feet wide, another small deposit was visible, which the manager claimed extended to the north-east for miles, he knew not how many. They were making no preparations to work these latter deposits, and their existence is disputed. The manager says another company owns the section north of them, but beyond that they owned a large territory.

There is one shaft sunk in the hill on the south side of the track to a depth of 60 feet, and from this they are taking small quantities of ore, which is handled in hand barrows. They have a small crusher of not over 75 tons capacity per diem. The furnace is of the English pattern, the same as used in the company's works at Swansea, England. It can reduce about 40 tons of ore per diem, and has been in operation about three weeks. Another similar but larger furnace is building. The works are not economically planned for working on an extensive scale.

Eight thousand tons of ore have been mined in the last year and a half, since the mine was opened. The ore runs about two per cent. of copper and nickel combined.

The matte is 8 per cent. nickel and 4 per cent. copper. The manager said he had orders to mine 40,000 tons next year.

The place cannot be in any way considered as a competitor of the Canadian Copper Company.

GENERAL SUMMARY.

| | Canadian Copper Co. | Dominion. | Vivian's. |
|---|---|---|---|
| Acres owned known to us..... | 13,000 | 480 | 320 |
| Additional claimed... | ..... | 5,000 | 4,000 |
| Amount of ore taken from mine to Oct. 1 | 105,000 | 45,000 | 8,000 |
| Daily crushing capacity, ore ..... | 1,200 | 400 | 150 |
| Daily furnace capacity, matte..... | 72 | 14 | 5 |
| Estimate of tons of ore above surface of ground in deposits seen by us. | 650,000,000 | 2,500,000 | 240,000 |

We visited the Fraser & Chalmers Company, and the Gates Iron Works, in Chicago, where the various statements concerning the capacity of the plant and embodied in this report were verified.

Very respectfully,

WM. M. FOLGER,
*Commander U. S. Navy.*

B. H. BUCKINGHAM,
*Lieutenant U. S. Navy.*

## Examination of Mineral Properties.*

By PROF. H. S. MUNROE.

The mining engineer, when called upon to examine a mineral property, should be prepared to answer the following questions, or their equivalent:

1. *Will it pay to work the deposit?*
2. *How much capital will be required to develope and work the property?*
3. *What is the property worth? Do you advise its purchase at the price asked?*

These questions involve more than is apparent at first sight. It may sometimes happen that the deposit is so large and rich, or so small and poor, that the first and most important of these questions can be answered at once. In such cases, however, the services of the mining engineer will hardly be required.

If it is at all doubtful whether the property is workable or not, we must ascertain the extent of the deposit, its average thickness and the probability of its continuance. We must determine the richness and purity of the mineral, and other things having influence on its market value. Finally it will be necessary to estimate the cost of mining and of preparing the mineral for market, the cost of transportation and the probable selling price. Each of these new questions will suggest further lines of investigation. For example, the cost of mining will depend largely on the scale of operations, and this, in turn, on the extent of the deposit, the market for the product, and many other things.

The value of the property depends on its capacity for earning profits or dividends, to determine which demands most careful and accurate estimates of capital, working costs and probable production, as well as the time required for the different operations, as affecting the question of interest.

Many, if not most of these things, are usually guessed at. The value of the estimates and conclusions in such case depend on the guesser's ability and previous experience in the particular kind of mining in question, and on his familiarity with the local conditions affecting the result. Such guesses are often far from the truth, and the consequences disastrous both to the reputation of the guessing expert and to those who invest their money on his recommendations.

The object of the present series of papers is to outline a method of procedure by which data can be obtained for careful estimates, and much of the uncertainty now attending the inception of mining enterprises removed.

It rarely happens that questions involving the scale of operations, the amount of capital required and the value of the property can be answered definitely, or even guessed at, until the nature and extent of the deposit have been determined by exploratory workings, costeaning ditches, drifts, bore-holes, prospecting shafts, etc.

Often large amounts of money have to be expended in such preliminary work before the true character and value of the deposit is known. Sometimes, indeed, it is even necessary to develope and work the deposit on a small scale before these questions can be definitely answered.

The examinations made by the mining engineer will then be of two kinds.

1. A preliminary examination of the undeveloped or partly developed property to determine whether further exploratory work is warranted by the "prospects," and if this prove to be the case, to decide upon a systematic plan of exploration which will give the desired information as to the nature and extent of the deposit.

2. A final and exhaustive examination of the property to obtain data to determine the best method of working, the scale of operations, the amount of capital required and the probable earnings and consequent money value of the property.

### PRELIMINARY STUDIES.

Before undertaking the preliminary examination the engineer should make himself familiar, as far as time and opportunity permit, with similar deposits in the same region and elsewhere. The study of developed properties, their history and the conditions under which mining has proved profitable, will be of great service. In some regions an ore yielding one or two dollars to the ton can be worked with profit. In other regions, under different conditions, an ore yielding twenty dollars will not pay expenses. In this study of similar deposits the engineer should also note carefully the associated rocks and characteristic minerals, the mode of occurrence of the useful minerals, and, in general, such features of the deposit as influence the value of the property and determine the mode of working.

In default of opportunity to examine similar deposits, much information can be obtained from geological reports, state and governmental; from the reports made by geologists and engineers on adjoining or similar properties; from the transactions of scientific and engineering societies, and from articles and correspondence in the technical journals. Finally it is assumed that the engineer is familiar with the literature of ore-deposits, and has had practical experience in mining operations and in field geology. Nothing, of course, can make up for the lack of this knowledge and experience.

### PRELIMINARY EXAMINATION OF THE PROPERTY.

In the preliminary examination of the property the following objects should be kept in view:

1. Endeavor to determine the geological character of the deposit, as for example, whether it be a regular bed or vein, or an isolated mass or impregnation.

2. Determine carefully the thickness and other dimensions of the deposit where exposed; its dip and strike, the occurrence of folds, squeezes, faults and other irregularities, and the nature of the surrounding or overlying rocks and soils.

3. Note the relations of the deposit to the surface topography, and to the natural lines of drainage and of transportation.

4. Determine the relations existing between different exposures of mineral on the property, and whether they are on the same or represent different deposits; also the relations between the deposit and exposed rock-formations.

### TOPOGRAPHICAL SURVEY.

As a basis for this work a topographical map of the property is indispensable. It is only necessary to enumerate some of the possible uses of such a map to make this evident:

1. The relations of the mineral deposits to the property lines can be seen; and steps taken, if necessary, to secure or control adjoining properties before the work of exploration and development is begun.

2. The relation of the different outcrops and developments, and whether they represent one deposit or several, can be determined: sometimes at a glance.

3. The area of the portion of the property underlaid by the deposit can be measured, and the available areas of mineral at certain depths and within certain boundaries determined.

4. If the geological structure be complicated, all the known data can be brought together on the map and sections, and advantageously studied.

5. The probable outcrop line can be determined and traced on the map as a guide to works of exploration and development.

6. If necessary, the underground contours of the deposit can be determined approximately; and the probable depth of a shaft, or the length of a tunnel, to reach the deposit can then be measured on the map.

7. Roads, buildings, and all surface works, and in general all the works of exploration and development can be much better located and planned with the aid of an accurate map than is possible without such assistance.

### SURVEYING FIELD-WORK.

When the property is small, or the problems simple, a sketch map will serve every purpose. This may be based on an outline plot from the description in the title papers.

When time and the importance of the work permit, a careful topographical survey should be made. All outcrops of the deposit, and of overlying and underlying rocks, should be plotted on this map in their true positions. From the measurements of dip and strike and level it will be possible to construct geological cross-sections and to determine the probable lines of outcrop as a guide to further exploration. Finally, the costeaning ditches, prospecting shafts, and other exploratory workings should be plotted from time to time on this map and on the sections, that the full import of the new developments may be studied as the work goes on.

When the property is covered with timber and underbrush the topographical survey may be made by the rectangular system. When the country is open, however, other more rapid and economical plans of work should be adopted. The expert topographer will not confine himself to any one system of work, but will in every case adapt his method to the conditions by which he finds himself surrounded.

If the rectangular method be adopted the base should be run along the line of the principal developments. From this base laterals will be run, 200, 300, or 500 feet apart, and prolonged as far on either side of the base as may be necessary. These laterals should be joined at their extremities by tie-lines parallel to the base line to check the accuracy of the work. The lines will be run with range-poles, by the compass, or by the transit, and the distances measured by pacing, chaining, telemeter, or steel tape, according to the importance of the work and the degree of accuracy required. To facilitate plotting the stations on these lines should be located at uniform distances, 200, 300, or 500 feet apart, and sub-stations interpolated when necessary for details. Finally, the levels of all stations will be determined by barometer, hand-level, water-level, or wye-level, according to the degree of accuracy desired. If the barometer be used, continuous readings should be taken at some reference point to determine the fluctuations of the barometric column during the day. A self-registering aneroid may be used for this purpose.

The contours should be sketched in the field, and not constructed in the office from the levels of the stations, as is too often done. This is especially important in the survey of mineral properties, as the configuration of the surface often throws much light on the underground structure.

When the country is free from underbrush the survey may be made with the transit and telemeter-rod. A series of closed polygons will be run along roads, ridge lines, and lines of natural drainage. From the main stations on these traverse lines sub-stations will be determined by radiating sights and telemeter readings. More distant points may be located by intersecting cuts. Vertical angles will be freely used for determining differences of level.

If the country be open much time will be saved, and the accuracy of the work increased by triangulation and by the use of plane-table methods. In many cases the plane-table itself may be used to advantage.

For open country, also, surveying by photography,* the camera being used as an angle-measuring instrument, will doubtless find increasing application. Not the least of the advantage of a photographic survey is the short time required for the field work. The photographs also supplant the map, and reveal details of topography which would otherwise be obscure.

### GEOLOGICAL FIELD-WORK.

A careful and systematic geological examination of the property will be made in connection with the topographical survey. All outcrops of mineral and of associated rocks should be examined and located on the map in their true position, elevation, and extent. The dip, strike, and thickness of rock exposed should be noted in each case, that the data may be accurately plotted on the sections.

Search for outcrop should be made on steep hillsides, on the crests of hills and ridges, in the beds of streams, in the roots of overturned trees, and in wells, cellars, quarries, road-cuttings, and other artificial excavations.

Even when the solid rock is not exposed the decomposed rocks and soils may furnish an indication of the character of the underlying rock. This, of course, is not the case in alluvial valleys, nor in regions covered by glacial drift. Elsewhere the decomposed rock, often 20, 50, or even 100 feet thick, remains nearly *in situ*. Sometimes the vegetation, shrubs, trees, etc., as characteristic of certain soils, may furnish important clews to the nature of the underlying rocks and minerals.†

Search should be made in the beds of streams and on hillsides for "float mineral" or "shoad stones," and for fragments of rocks and minerals known to be associated with, and characteristic of, the deposit. By tracing such float up the stream, or up the hillside, the outcrop may sometimes be found, or at least approximately located.

The outcrop of a metalliferous vein frequently manifests itself as a line of rocks stained with oxide of iron, often honeycombed and porous, the "*gossan*" or *eisen-hut*, the iron oxide of which results from the decomposition of the pyrites, usually present as a constituent of such veins.

The bed of fire-clay under a coal-seam, being impervious to water, frequently determines the horizon of numerous springs issuing from the hillsides. As the coal and

* School of Mines Quarterly.

* *Photography Applied to Surveying.* Lieut. H. A. Reed. Wiley & Son, 1888. Also, *Modern Methods and Apparatus for Surveying* H. S. Munroe, *Trans. Am. Inst. of Mining Engineers*, vol. xviii. (in press).

† See "Indicative Plants." R. W. Raymond. *Trans. Am. Inst. Mining Engineers*, vol. xv., p. 644.