ECONOMIC GEOLOGY

By DR. G. F. LOUGHLIN.

Economic geology is, in its broadest sense, the application of the several principles of geology to problems affecting the welfare of mankind. It deals, therefore, not only with mining and quarrying, but also with various engineering undertakings, two striking examples of which are the water-supply development of New York and the building of the Panama Canal. The training of the economic geologist, even though it specializes, must be liberal, both in geologic and other subjects. Thus the mining geologist, in addition to his thorough acquaintance with ore and gangue minerals, must have a sound knowledge of structural and chemical geology and petrology and a fair knowledge of physiography and paleontology. Such knowledge to be adequate, can result only from careful and patient studies, both in the field and in the laboratory. He must also be familiar with the principles of metallurgy, surveying and economics.

The importance of structural and chemical geology needs little illustration. Without such knowledge it is in many cases practically impossible to follow and to work ore-bodies intelligently, to recover lost ore-bodies, or to estimate the amount and continuity of the ore. Some ore-bodies, for example, rich at the surface, are at slight or moderate depth, too lean to work; others, barren at the surface, may be rich at slight depth, only to become lean as depth increases. The composition of the ore, and its influence upon metallurgical methods must be appreciated in the field. Realization of the origin of ores is, in many cases, of vital importance in predicting the future of a mine.

Petrology is so closely related in mining work to structural and chemical geology, that the above illustrations could in part be repeated here. Where ores, as is commonly the case, are localized in certain kinds of rock, it is indispensable to successful mining that the extent of the ore-bearing rock and its relations to other rocks of the district be known. Petrology furthermore, is one of the chief assets of the prospector.

Physiography is a subject too often neglected by students of mining geology. Although it is of but little importance in many mining districts, it holds the key to the situation in others, for instance, the " ancient" placers of the Sierras and the modern placers of California, Alaska, and elsewhere. In Alaska the distribution and relative richness of placers has been understood from study of the changes in the development of river systems.

Paleontology, like physiography, may or may not be of vital importance to the mining geologist ,according to the district in which he is working. The reader will find illustrations of the use of paleontology in Prof. Shimer's article.

The courses in economic geology given at the Institute to students of mining engineering presuppose training in all the above subjects, as well as in other related studies. The students, with this preparation, are given a general knowledge of the principles of mineral deposits in lectures and conferences, and study specific cases in the laboratory. This general training may be continued by graduate work along certain chosen lines, and may be carried on in connection with government, state or private work.

The study of building stones is largely a practical application of petrology to the needs of architects and civil engineers. Though a subject of rather limited scope, it is especially one in which there is need of good judgment rather than hard and fast rules. The importance of the subject to architects is amply illustrated in the buildings of our larger cities, where disfigurement of many handsome specimens of architecture is due, directly or indirectly, to ignorance of the most elementary principles of petrology.

The needs of the civil engineer in construction work may in some cases be essentially the same as those of the architect, although they may be quite distinct. Stones of little use to the architect may be the best available for the engineer, as was the case in the building of the Ashokan Dam in New York State. The engineer should be acquainted not only with the properties of stone for building, but also with conditions likely to be encountered in the tunelling and other excavation of dif-

(Continued on column 4.)

SUMMER SCHOOLS

By PROF. CHARLES E. LOCKE.

No summer courses have ever been given in the Mining Department. For a few years assaying was offered as one of the summer courses to be given at the Institue, but a sufficient number of men did not apply to warrant the giving of the course. On the other hand the professional summer school has been a regular feature of the training for over thirty years. The object was to enable the student by visiting mines and metallurgical works to gain a practical knowledge of the subjects that were taught in the class room. This work has always been optional owing to the expenses involved ($75 to $100), coupled with the fact that a student who has to work to secure money during the summer time is robbed of at least a month's time. A required summer school would prove a hardship for some men and might even prevent a needy fellow from taking the mining course. The benefits of such a summer school are threefold: first and foremost, the knowledge gained by the student; second, the connection that is gained with the mines and plants visited; and third, the publicity that is given to the Institute by a party of instructors and students which in a series of years cover various districts within a thousand miles of Boston.

Summer-school trips are divided into mining and metallurgical, and have been taken in alternate years so that a man could visit mines one year and metallurgical plants the other. To derive the maximum benefit a man should not take a summer school until after his second year. Two plans have been followed on the mining trips, one to visit a small mine and make a detailed study of it and also get surveying experience with the transit and plane table, the other to travel more extensively and visit several mines getting a broad view of the operations at each. On the whole the latter plan seems best on the general principle that school training should give broad fundamental ideas and leave details to be learned in practical work after graduation.

The first summer school was held in 1871 when a party under Prof. Runkle visited Colorado and Utah.

In 1908 only two men applied but the school was held, neverthless. The smaller the party the better is the instruction received by the men, but on the other hand, it is a question whether the Institute in its present financial condition is warranted in using funds for a small summer school which can be used to better advantage in other ways. In 1909 no men applied, and no school was held. In the future the school will be offered every year, but it will not be held for less than six men.

The cause of the diminution of numbers in the summer school is to be found in the increased number of men who secure practical work during the summer. At the present time statistics show that over ninety per cent. of the men in the graduating class have had practical work of some kind during their vacations. Ten years ago only a small per cent. of the men had had practical work at the time of their graduation. The department has made special efforts to secure this work and during the last summer was able to supply positions to all undergraduates who applied. Compared with the summer school this practical work has two advantages:—first it gives an income to the student instead of an outlay, and second, it is considered that a whole summer spent in practical work at one place is more profitable from every point of view than a visit of from three to four weeks to different plants. As for the future, one cannot say just how the whole matter will work out. It seems very likely that before long one of the requirements for graduation will be that a student either shall have taken a summer school or shall have spent a vacation in practical work.

The relation of school work to practical work is very important and may be adjusted in various ways. Our old system of a sequence of school work, graduation, and then practical work gave good results as shown by the present high positions of former graduates. The peesent system of school work mixed with practical work during vacation ought to yield even better results. Still another system which prevails in some places is to have a mine run by students in connection with school work. Students drill and blast, timber, survey and carry on all the operations of mining. This looks very attractive in-

FIELD GEOLOGY

By MR. C. H. CLAPP.

Field geology is to the geologist what surveying is to the civil engineer; indeed courses in the subject are ordinarily designated as geological surveying. The geological surveyor goes into the field, notes the different types of rock exposed, maps the distribution of each kind, and determines as far as possible their relation to each other, and to the whole geological province. The last of these duties is the most difficult, the most illusive, yet the most important. It should never be lost sight of during the field mapping any more than the unity of a composition, or a picture should be lost sight of during the working out of the details. In the determination of rock structure and rock relationship, the geologist becomes more than a mere observer but an interpreter of observed facts. In large part, however, field geology consists in observing and recording the facts of geology.

These facts are recorded in the field, usually on topographic maps which have been previously prepared for the geologist's use. Each rock formation, which is shown on the geological map, is given a particular color or pattern, so that by reference to an explanatory legend, one may readily acquire a knowledge of the various types of rocks occurring in the region represented by the map. The distribution of each formation is shown on the map by the extent of each color, or pattern. The locating or "tracing" of the boundaries or "contacts" of each formation therefore becomes of paramount importance. It is also along the contacts that the relationship between the contiguous formations are usually best exposed. The relation may often be shown directly on the map in some conventional manner, or more commonly is indicated by "structure sections." These sections give the altitude of each formation, and their relation to each other, as these features would appear if a deep slice was made in the earth's crust, along the line of the section, and the cutting exposed to view. Such sections are, in part, theoretical, but if constructed with care, have a very high degree of probability. Thus by means of maps and sections it is possible to represent the various rock formations as they actually exist in nature.

Geological maps are prepared and published by the various state and national geological surveys. The published maps may be obtained by any one interested in a particular district, free, or at a nominal cost. Geological surveys are also often carried out by private individuals and corporations, notably railroads and mining companies. Such surveys are usually of a detailed and special nature, but are based on the larger, more general surveys carried on by the government.

Geological data which is made available through maps and reports, becomes of direct practical importance when applied to certain business enterprises, not only those dealing primarily with the exploitation of the mineral resources of a region, but with all that have to do with underground work of any kind. It is necessary to know, for instance, in the construction of a tunnel, what kind of rock will be encountered in the center of a hill or mountain range, as well as on the flanks. The geological structure must also be considered. In the development of the mineral resources of a country, geology is of the foremost importance, especially in the location of mineral deposits. Certain deposits such as coal, occur as beds in well defined formations, the underground structure of which may be foretold with a great deal of accuracy from an examination of surface features. Some formations at certain critical places are favorable for the location of metallic ores, and the recognition of these places is one of the chief duties of the field geologist working in undeveloped regions. Large areas of rock may sometimes, almost assuredly, be determined as non-mineral bearing, and the expense of a large amount of worthless prospecting may be thereby saved. In the working of deposits of metallic ores, it is necessary to arrive at some conclusions as to the origin of the ores in order to gain the assurance which is necessary to sink shafts and drive tunnels for long distances. The various theories of the genesis of different types of ore deposits are intimately related to the theoretical geological history of the particular region in which the ores are found.

All geological theories and speculation must be based primarily on field work. Those hypotheses which do not accord with the observed field facts must of course be discarded. Discussion properly follows the accumulation of data. Field facts were overlooked by the earliest geologists in favor of certain preconceived ideas; they preferred to speculate rather than to observe. Interprtation is a necessary corollary of observation; the bare facts must be moulded by imaginative thinking into an understandable sequence and form. Field geology is, however, the basis, the foundation not only of speculation, but even of the theories and hypotheses which today are ordinarily accepted as the truth.

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deed, but close examination shows that it can never compare with work in a commercial mine. This was well demonstrated by the Crocker Summer School held in Colorado in 1903 and participated in by Columbia, Harvard, Technology, and Yale. A mine was leased and operated by students under the supervision of practical miners. Although this was probably the most successful summer school ever held still it lacked one important essential namely, the atmosphere of work. This leads to the conclusion that the best combination is the school for theory, and work in a commercial mine for practice, the number of students in any one mine to be a very low proportion of the total men employed.

ECONOMIC GEOLOGY.

(Continued from column 1.)

ferent kinds of rock. He should, therefore, like the mining engineer, have some training in structural geology as well as petrology.

Water-supply problems may require for proper solution application of the several branches of geology, especially of physiography and in some cases of paleontology, as is illustrated by the investigations of Prof. Crosby for the New York Water-Supply Board. That great general question, the conservation of natural resources, also depends upon the several branches of geology for its answer.

Proof of the present appreciation of economic geology lies in the rapid growth of the science in late years. The United States Geological Survey, maintained largely for its aid in the development of the country's mineral resources, has done much towards placing economic geology upon its present basis. The results of the Survey' work have induced many states in all parts of the union to organize state surveys. Several private corporations, especially those operating mines and railroads in the west, permanently employ geologists, while a few geologists are successfully established in independent conulting work.

Economic Geology, utilizing as it does all other branches of geology for the common good, is necessarily the most important and advanced branch of the science. It is with this fact in view that the geologic courses at the Institute are given.

CONCENTRATES.

It is interesting to note that the mining course of the recently established Nova Scotia Technical College, as set forth in their catalog, seems to be patterned on the mining course given at Tech. Prof. Richard's "Mining Notes," former Prof. Lodge's "Notes on Assaying," as well as other Institute books are used in the Nova Scotia Tech.

Professor Sexton, the Director of Technical Education for the Province of Nova Scotia, graduated from the Institute Mining Course in 1901.

That the instruction given in geology at Tech is second to none is shown by the number of men that the Geological Survey of Canada sends to the Institute for graduate work. Last year, five men from Ottawa were here doing research work, or candidates for advanced degrees, and again this year, five men connected with the Canadian Survey are at the Institute.