slit formed by that portion of the pencil which at every incident angle undergoes reflection is tinted by the rays so sent back.

As in all such work, the sharper the beam the better the results, but I find the experiment succeeds very well indeed with the beam obtained by projecting with the ordinary optical front a narrow slit in the stage of my electric lantern.

F. W. MCNAIR.

MICHIGAN MINING SCHOOL.

SCIENTIFIC LITERATURE.

Annual Report of the Geological Survey of Canada for the Calendar Year 1894. G. M. DAWSON, C. M. G., LL. D., F. R. S., Director.

This volume is No. 7 of the New Series of Reports of the Canadian Survey, and comprises 1,206 pages, accompanied by eleven maps, fifteen plates and diagrams, besides figures in the text. It is a storehouse of facts relating to the geology of all parts of the Dominion, and is the first of the reports prepared by the guiding hand of the new Director.

The staff of this organization, including all employees, professional and ordinary, numbers fifty-one persons, and the total amount, expended sum up $110,000 for the fiscal year ending June 30, 1894. The several reports are, first a summary of all the operations by the Director; then an account of the geology of the Kamloops map-sheet in British Columbia, by Dr. Dawson; an exploration of the Finlay and American rivers in the north part of the same province, by R. S. McConnell; preliminary report upon the south part of the district of Keewatin, by D. B. Dowling; the geology of the southwest sheet of the eastern townships, by R. W. Ells and F. D. Adams; the surface geology of eastern New Bruswick, northwestern Nova Scotia and a portion of Prince Edwards Island, by R. Chalmers; upon the chemistry and mineralogy, by G. C. Hoffmann; upon mineral statistics and mines for 1893 and 1894, by E. D. Ingall and H. P. H. Brumell, and many paleontological notes interspersed here and there by J. F. Whiteaves and H. M. Ami.

Out of such a mass of information one can only refer to matters in which he is most interested.

At Athabasca landing, near the Canadian Pacific Railway, a trial boring has been effected to the depth of over 1,000 feet for petroleum. Beds of soft Cretaceous sandstones from 140 to 225 feet in thickness, for a distance of ninety miles along Athabasca river, are more or less saturated with bitumen. It is believed that the petroleum occurs in Devonian strata, which in the neighborhood underlie the Cretaceous. As the tar sands proved to be somewhat thicker than was expected, and various difficulties arose, partly in connection with the large supplies of gas exhaled, operations had not been completed at the time the report was made; and it was thought it would be necessary to continue this boring five hundred feet further before abandoning the location. The probabilities seemed ample for expecting the development of another oil field in this district.

The statistics of production of valuable minerals give a total value of $20,950,000 for the year 1894, which is a slight falling off from the yield of the previous year. The more valuable products in the order of their importance are coal, nickel, bricks, building stone and gold, the last having the value of $1,042,055. British Columbia produced the most, $456,066, followed closely by Nova Scotia. The Columbian mines are almost entirely worked in placers of Pliocene age, derived from auriferous veins in the Carboniferous and Triassic rocks. Dr. Dawson states that "British Columbia has now fairly entered on a period of rapid and thorough development of its mineral resources."

Perhaps with the idea of promoting this development, large space is given to the description of the geology of the Kamloops sheet, with a map descriptive of an area about eighty miles square, just above the latitude of 50° and comprised between longitudes 120° and 122°, through which the Canadian Pacific Railway takes its course. The aggregate thickness of the formations in this field is 79,500 feet. The Archean is wanting, though present just to the east of longitude 120°. The Cambrian consists of two parts: the lower, or *Nisconlith* series—dark argillites; and the upper, or *Adam's Lake* series—volcanic beds with arkose conglomerates; both amounting to 11,500 feet. The Silurian and Devonian have not

been recognized. The Carboniferous or *Cache Creek* series is 12,000 feet thick, one-third limestone. Its character is like that of the corresponding limestones and quartzites of corresponding age observed in our Fortieth Parallel Survey. The Triassic, or *Nicola* group, occupies a considerable area, with a thickness of 10,000 to 15,000 feet comparable with the rocks of the same age in Nevada. The materials are largely volcanic, diabase porphyrites becoming amygdaloidal; also agglomerates passing into diabase tuffs. The sediments are marine limestones and argillites. Certain limited areas are believed to be Lower Jurassic, though not separated upon the map.

Passing the Cretaceous development, the Oligocene Tertiary, or *Coldwater* group, is quite important, its materials consisting of aqueous deposits, conglomerates, sandstones and shales, in some places holding coal and lignite. None of the beds are marine, and all are said to be separated from the Miocene by unconformity.

Fully half the area of the map is occupied by the Miocene, which is composed of volcanic rocks over 9,000 feet in thickness. The lower division consists mainly of augite-porphyrites; the middle of fine-grained tuffs that have been laid down in water containing beds of lignite, perhaps of merchantable value, and the upper of basalts, melaphyres, etc., easily seen to have been ejected from numerous local vents. Fossil plants have been collected from all parts of the Cretaceous and Tertiary series, and serve for the basis of the stratigraphical reference and assignment.

The granites found in the Kamloops area are of medium coarseness passing from biotite-granite to hornblende-biotite granite, are sometimes foliated, especially near their contact with Paleozoic strata, and are probably post-Archean in age.

Perhaps the most interesting part of the volume is the description of the geology of the Montreal sheet by Dr. Ellis. This area lies between latitudes 45° and 46°, immediately north of the international boundary and between longitudes 72° and 74°. It is the first area studied carefully by the Survey, as it embraced the vicinity of Montreal, the chief city of the Dominion; and it is interesting to United States geologists because the formations pass from it into our territory. It has also great historic interest, as it has been the field of vigorous controversy.

Before 1860 it was supposed that its structure furnished the key to the solution of the metamorphic problem of eastern America. Studies by Sir William E. Logan furnished the foundation for a peculiar paleontology, which referred the terranes southeast from the St. Lawrence to the horizon of the Chazy-Calciferous; some of these had, in the previous decade, been referred to the Medina or Middle Silurian. Because of the accurate stratigraphical and paleontological studies of this area, it was claimed that the extension of the terranes southerly defined the age of the crystallines of New England, all of them being Silurian or Devonian. The Vermont Geological Survey had accepted these Canadian conclusions, fortified, as they were, by the opinions of Professor James Hall. But the Vermonters could not accept Logan's intepretation of the structure of the Green Mountains as they continued into Canada. Logan called it the 'Danville and Sutton Synclinal;' whereas on the southern side of the boundary line no interpretation of the dips could justify any such structure. In the midst of these perplexities of adjustment there came, at the end of the year 1860, a communication from Sir W. E. Logan containing a letter from Barrande affirming the primordial (Potsdam) age of the trilobites referred by Hall to the Hudson River group, and the consequent abandonment of a belief in the Silurian age of the Olenellus slates. Much readjustment of the details has been required, and it is only now, thirty-five years after the publication of Barrande's letter, that the details are properly presented. Instead of the 'Danville and Sutton synclinal' Dr. Ellis gives us the 'Sutton mountain anticline,' and there are broad expanses of pre-Cambrian and Cambrian terranes to take the place of the former Middle and lower Silurian. This pre-Cambrian Green Mountain area is about twenty miles wide at the international boundary, flanked on both sides by a Cambrian terrane and there by the Cambro-Silurian. On the west side the Calciferous sandrock seems to be absent be-

tween the Cambrian and the Chazy-Trenton limestones of Farnham. On the east side the Cambro-Silurian succession involves the reference to a lower horizon than has been commonly accepted, of the micaceous limestones which pass into the group termed the 'Calciferous mica schist' in the Vermont and New Hampshire reports. This reference is based upon discoveries of graptolites about Lake Memphremagog clearly of the age of the lower Trenton.

In the St. Lawrence plain country there are very few strata referred to the upper Silurian; but on the Memphremagog side well-defined Niagara and Devonian fossils are abundant.

This area has also afforded much material for petrographical studies in the series of bosses and eruptive masses of diorites, diabase, syenites and late granites extending from Stanstead across the whole sheet to the Laurentian gneisses and anorthosites of the northwest corner back of Montreal, a part of the original Laurentian area of Logan. The anorthosites are now clearly understood to have had an eruptive origin; and hence the original conception of an upper Laurentian or Labrador system of stratified rocks is abandoned.

The Dominion of Canada now furnishes us the most important field for the study of glacial phenomena. By slow degrees the existence of an outer margin and various terminal or recessional moraines has been proved for the United States; and it remains needful to explore the districts farther north up to the Arctic regions in order to find additional moraines and the starting points of the ice movements. Dr. G. M. Dawson, the Director of the Survey, has given names to two parts of what has been called the continental ice mass. One is the *Laurentian* and the other the *Cordilleran* glacial sheet, each with an independent existence, but sending out ice streams which have coalesced in the great western plains. The Cordilleran mass was somewhat the smaller of the two, having at its maximum development a length of 1,200 miles. The main gathering ground or *nêvé* of this ice sheet lay between Latitudes 55° and 59°; and the ice flowed northerly, into Alaska 350 miles, westerly into the Pacific Ocean, southerly as much as 600 miles, into the edge of the United States, and southeasterly over peaks rising to altitudes of over 7,000 feet; thus implying a thickness of over 6,000 feet above the principal depressions of the surface. Dr. Dawson thinks there were two maximum periods of glaciations in the Cordilleras, followed by subsidences, in the first case 500 and in the second to 2,500 feet below the level of to-day. There are numerous terraces of boulder clay and white silts corresponding to these levels. Indeed, judging from the descriptions and views of these high terraces, there is nothing comparable with them anywhere else upon the continent.

From the report of Mr. Low it would appear that the central part of the Labrador peninsula was the gathering ground of the Laurentian ice sheet, from which glaciers flowed off in all directions, notably to the west, east and south. The striæ indicating the westerly movement are the least distinct.

Mr. Robert Chalmers reported upon the surface geology of the maritime provinces. He finds evidence of ice movements northerly and easterly from the higher elevations in northern New England and Quebec, as well as southerly in the St. Johns valley. No ice reached the peninsula of Nova Scotia from the mainland except to a very slight degree; and the glaciation effected is explained by supposing radial movements from the Cobequids and the watershed of the main peninsula. The general conclusion drawn is that there was no movement from the St. Lawrence valley up and over the New England highlands towards the sea. All the phenomena are to be explained upon the theory of local glaciers moving outwardly to all quarters of the compass from the greater mountains. Instead of our going to Canada for the source of the New England glaciation, the Canadians now come to the White and Green mountains in search of the ice which brought débris into the St. Lawrence valley. The writer would remark that these conclusions are undoubtedly correct for one of the later epochs of glaciation. The glaciers of the Champlain age entering the St. Lawrence valley, both from the Labrador peninsula and the New England summits, brought icebergs which floated over Montreal and Quebec and induced the severe climate, lasting for a long time, which was suitable for the habita-

tion of the boreal mollusca. For this reason the till of the lower St. Lawrence valley seems to have been deposited under marine conditions, covering up all the marks made by the earlier ice sheets. Hence it is not strange that the Canadian geologists have so generally given the largest place to icebergs in their conceptions of the work done in the ice age.

The perusal of this volume clearly shows the great efficiency of the Director and his assistants in carrying on the work so ably commenced by Logan and Selwyn. The field work has been carried on economically and successfully. While theories of divers kinds are advocated, there seems to be no attempt to distort the facts to square with preconceived notions, and all will hope that abundant means will be continuously supplied to the survey organization to carry on its explorations in a manner honorable to the Dominion government.

C. H. Hitchcock.

Tables for the Determination of Minerals by Physical Properties ascertainable with the aid of a few field Instruments based on the system of Prof. Dr. Albin Weisbach. By Persifor Frazer. Lippincott. 1897. 4th edition enlarged, 163 pp.

The first edition of this book appeared in 1874 and has been followed by the succeeding editions at varying intervals (1877, 1891, 1896).

This is really an authorized translation of the German work of Weisbach, to which Professor Frazer added the empirical formulæ best representing the data at hand. Few changes were made till the publication of the third edition which appeared rewritten and considerably changed in detail, though following the lines laid down in the first edition. The chemical formulæ previously used were replaced by those given by Groth in his 'Tabellarische Uebersicht der Mineralien,' and to the tables were added the characteristic habit, structure, fracture, specific gravity and association of the minerals.

The present edition is an enlarged and corrected reprint of the preceding. To the seven hundred and sixty odd species and subspecies previously included, there have been added a hundred and thirty-five others, which embrace several old and well known species, like microcline, and many minerals which recently have been described or rendered of economic importance, like monazite.

As in the earlier editions, the only instruments necessary are a knife, streak table, file and pocket lens. The classification is based on the lustre, streak and hardness, thus dividing the minerals into sixteen different classes upon criteria which are easily determined by the practical manipulator. The book is intended to be of service to the student, as an artificial aid to memory; to the field geologist, as a reminder and handy book of reference for properties of unusual minerals; and to the amateur, as an incentive to more accurate observations.

The author, for the sake of economy, in using the old electrotype plates, has, in a measure, decreased the value of the book, as their use has caused the retention of features which to-day savor of an earlier period in mineralogy. At the present time there is a tendency to discard even the well known crystallographic symbols of Naumann in favor of the Miller system. The present book, however, retains the abbreviated Naumann symbols suggested by the elder Dana, without incorporating the modifications introduced in the last edition of E. S. Dana's Manual of Mineralogy. A still more pronounced archaism is the introduction of such 'mineral species' as *pitchstone* and *perlite* which belong to rocks and not to minerals. Similar criticism might be passed on the ambiguous use of the term 'andesite,' which on page 92 is used to designate a mineral, while on page 99 it designates a rock; or the term *pegmatite*, which is given as a varietal name for orthoclase.

Turning to the tables themselves, there seems to be looseness in the choice of values given for hardness and specific gravity; the habitat or association of the minerals, and the symbols used as abbreviations.

In turning over the pages, the eye catches such deviations from the hardness, as on page 90, where the opal is ranked as '5' (Dana 5.5.–6.5), or the separation of 'andesite' on page 92 from laboradorite on page 100 (both 5–6). The choice of values for density may be illustrated by those given in the mica group, where the higher limits seem to be preferred,