Holland possesses the great advantage of holding the mouths of the Rhine, the Maas, and the Scheldt. Her means of river communication with Germany, France, and Belgium, are unbounded; and the possession of a length of 930 miles of canals and 340 miles of rivers enables her, apart from her railways, to carry on her large trade with greater facility of transport than, perhaps, any other European country.

Belgium shares with her northern neighbor the advantages of an elaborate system of waterways. By far the most important river is the Scheldt. Thanks to its unique position at the head of a tidal estuary, to the abolition of the Scheldt dues, and to the foresight and liberality of the Belgian government, which has spent $20,000,000 on dock and river works since 1877, Antwerp has now become in many respects the foremost port of the continent. Besides her 700 miles of navigable rivers, Belgium possesses about 540 miles of canals, by means of which communication exists between all the large towns and chief seaports of the kingdom.

France has built up, and is constantly extending, an elaborate system of canals and canalized rivers. Of the latter, the Seine is the most important in regard to the artificial works undertaken for its improvement, and for the tonnage of the traffic, which was in 1872 more than one-eighth of the whole waterborne traffic of France. The Loire, the Garonne, and the Rhone have all been largely benefited by the art of the engineer. The canal system of France is historic; one of the earliest of these artificial cuts being the celebrated canal of Languedoc, 171 miles long, built in 1667–81, and now forming part of the Canal du Midi. From its summit-level 600 feet above the sea, it communicates with the Garonne, and therefore with the Atlantic, by twenty-six locks, while its southern slope descends by seventy-three locks to the Mediterranean. Up to 1878, on 7,069 miles of waterways, France had spent upwards of $215,000,000. Nevertheless, it is intended still further to extend this means of communication at an estimated further cost of $200,000,000.

Spain and Portugal possess, partly in common, eight principal rivers, of which five — the Minho, Douro, Tagus, Guadiana, and Guadalquivir — drain the western valleys, and flow into the Atlantic; while the other three — the Ebro, Incar, and Segura — discharge into the Mediterranean. As a rule, these rivers are only navigable for a limited portion of their course, and are chiefly remarkable for extremes of flood-discharge; a velocity of sixteen knots an hour having been noted in the Douro under certain conditions of tide. The canals of the Iberian peninsula are unimportant. Spain possessed a length of 130 miles in 1875.

Italy is not rich in waterways except in the valley of the Po, the navigable portion of her rivers only attaining an aggregate length of 1,100 miles. Although the total length of navigable canals in Italy is only 435 miles, the Italians were the first people of modern Europe that attempted to plan and execute such artificial waterways. As a rule, however, they have been principally undertaken for the purposes of irrigation.

Austria-Hungary possesses in the Danube the largest river in Europe as regards the volume of discharge, although it is inferior to the Volga in the length of its course and the area of its basin. This great stream first becomes navigable for flat-bottomed boats at Ulm, 130 miles from its source. In its total length of 1,750 miles, it is fed by at least 300 tributaries, many of them large rivers. Although the Danube between Vienna and Old Moldova had been regulated in numerous places and at great cost, there had been but little appreciable improvement effected in its general navigable depth. On this account, projects having in view the permanent acquisition of a sufficiently wide channel, of from six to eight feet deep at every point between Passau and Basias, have lately been prepared, which involve an outlay of $10,000,000 to effect the desired improvements. Traffic on the upper and lower Danube is mostly carried in barges, of which the greater number gauge 250 tons. The effect of the improvements at the Sulina mouth has been to increase the trade from 680,000 tons gross in 1859, to 1,530,000 gross tons in 1883, and to lower the charges on shipping from an average of five dollars per ton for lighterage, to half a dollar per register ton at the present time for commission dues. As a commentary on the hostile criticism evoked when the scheme was initiated, the lecturer drew attention to two facts; namely, that the works so unsparingly criticised in 1857 had already effected a saving of $100,000,000, and that experience had abundantly proved that the predictions of a rapid silting-up to seaward of the Sulina piers had been completely erroneous.

THE GEOLOGY OF WISCONSIN.

THE nearly simultaneous appearance of the two final volumes of the 'Geology of Wisconsin' some months since, marked the close of one of the most rapid of the state geological surveys, and, for the time and money expended, one of the most thorough and complete. The work has been done in less detail than in some other states, whose surveys have run through much longer periods of time, and have consequently necessitated much greater financial outlays. The results are embodied in four large octavo volumes, containing something more than three thousand pages. The text is well illustrated; and the judicious use of cuts, which express much more than the best verbal descriptions occupying the same space, has contributed to the embodiment of a large amount of material in relatively small compass. In the same line may be noted the predominance of observational results over theoretical deductions, and the absence of irrelevant discussions which have sometimes served to swell

Geology of Wisconsin. Professor T. C. CHAMBERLIN, chief geologist. 4 vols. Madison, Wis., 1877–83. 3,147 p., 140 pl. 8°

similar publications. The accompanying atlas sheets, more than forty in number, add much to the value of the reports.

The leading contributors are Prof. T. C. Chamberlin, chief geologist, and Messrs. R. D. Irving, Moses Strong, R. P. Whitfield, Charles E. Wright, T. B. Brooks, E. T. Sweet, L. C. Wooster, and F. H. King. In connection with lithological determinations and reports, stand the names of Irving, Wichmann, Pumpelly, Van Hise, and Julien. Vol. i. also embraces reports on selected topics in natural history, notable among which is King's report on the economic relations of our birds.

A characteristic feature of the publications is the relatively large amount of practical information brought within the reach of the intelligent citizen who has little technical knowledge of science. Indeed, the oft-repeated question of which every geologist must be weary — 'What is the object of the survey?' — would hardly be asked by one familiar with the results of the survey of Wisconsin. In vol. i. appear several chapters of economic import, the express purpose of which is to make easy of comprehension the principles which are involved in such every-day matters as the sinking of artesian wells, the manufacture of brick, tile, etc., the selection of building-stone, the relations of soil to fertilizers, where and how to search for ore-deposits, — questions concerning which the opinion of the geologist is of practical worth.

Attention has throughout been directed to known mineral resources with a view to their future development, and particularly to those formations which, from their relationship to productive mineral-bearing formations elsewhere, or for other reasons, were thought, from an economic point of view, to merit careful investigation. The benefits, both positive and negative, which have accrued to the state as the result of such investigations, have already been considerable, and will doubtless be still greater in time to come. Other natural resources have not been neglected. Attention has been directed to various building-stones of considerable merit; and some of them, in consequence, have already found their way into the market. The subject of artesian wells has received special study at the hands of the chief geologist. It is doubtful if the problem of subterranean water-supply over a commensurate area of such diversity of character is anywhere better understood.

The survey has done more than assist in the development of natural resources, and its work is to be commended for other than economic

reasons. The science of geology has received no insignificant contribution in these publications. Much light has been thrown upon some unsettled problems; and if they are still unsettled, or if their solutions are still disputed, the contribution is not less real, because the data afforded by the state are insufficient bases for positive conclusions. Each formation of the state has been carefully mapped; its stratigraphical relations determined; and its fossils, when fossils exist, identified. Ninety-four new species are described and figured, as also are some of the more characteristic forms previously known.

Among the more important and interesting results are the determinations which have been made respecting the subdivisions of the archaean formation, and those which pertain to glacial geology. Concerning the former, the Wisconsin geologists recognize three distinct groups of rocks, — the Laurentian, Huronian, and Keweenawan. These groups, it is maintained, are not only distinct, but separated by intervals which, in point of time, were of no inconsiderable duration, — intervals long enough in each case to allow profound changes, both stratigraphical and petrographical, to be accomplished during their continuance. The evidence cited in support of this subdivision, as well as that bearing on the distinctness of the Keweenawan from the Potsdam formation above, is of a positive and perfectly definite character. The greatest break is held to occur between the Laurentian and Huronian series. The rocks of the Laurentian series are much more highly metamorphosed than those of the Huronian which overlie them; they are in a highly folded and contorted state, while the Huronian rocks have suffered notably less stratigraphical distortion; the laminations of the two series, when seen in contact or proximity, are discordant; the later series contains, at its very base, material from the older highly metamorphosed rocks; and the relations of the two series to penetrating igneous rocks are such as to emphasize the conclusion to which the other lines of evidence point. Altogether, the evidence upon which the subdivision is based is strong, and, for the region under consideration, is certainly convincing. The separation of the Keweenawan rocks from the Huronian on the one hand, and from the Potsdam on the other, rests on scarcely less positive grounds. The question as to whether the Keweenawan group is to be classed as Cambrian or pre-Cambrian, is one concerning which there remains room for doubt. In any event, the important fact developed is the existence of a distinct formation younger than the Huronian, and unconformably subjacent to the oldest formation of the interior known to contain Cambrian fossils.

At the other end of the geological series equally important advances have been made. For the study of quaternary geology, Wisconsin is an exceptionally good field, because of the proximity of driftless, old-drift, and new-drift areas. The determination in 1874, of the morainic character of the previously known 'Kettle Range' of eastern Wisconsin, gave a new impetus to the study of the drift phenomena. Following this important determination was the demonstration of the character of ice-movement in a relatively level region, as exemplified by the ice which occupied the Green-Bay valley. The proof of the lobation of the ice-margin followed, and the facts and principles here first developed have been the key to the explanation of glacial phenomena since studied from the Atlantic to Dakota. The determination of hitherto unsuspected moraines, and the connection of these with each other and with moraines previously known, but not known to have more than local developments, quickly followed in the wake of the first determinations in Wisconsin. Another result, scarcely less significant, was the recognition of two clearly differentiated ice-epochs in the glacial period, separated, according to Professor Chamberlin, by an interval which may not have been less than the time which has elapsed since the last. Although the existence of two ice-epochs is not yet universally admitted, the drift phenomena of Wisconsin, especially when considered in connection with like phenomena throughout the interior, place the hypothesis upon a substantial basis. Although later investigations have slightly modified the borders of the driftless area as mapped by the survey, the reality of its existence is beyond question; and it is just as certain that between this area and that bounded by the Kettle Moraine, which marks the limit of ice advanced in the second epoch, as interpreted by Professor Chamberlin, there is an area covered with glacial drift, which, as indicated by the greater amount of erosion which it has suffered, is of much less recent origin than that within the Kettle Moraine.

The consideration of the ore-deposits of south-western Wisconsin constitutes one of the more valuable portions of the reports. The author accepts the general conclusions concerning the manner of deposition reached by Whitney some years since, but works out the

theory much more in detail, and for the first time makes it complete. For this thoroughgoing treatment of the subject by the chief geologist, the excellent topographic and geologic work of Mr. Strong prepared the way.

Wisconsin is to be congratulated upon the successful completion of a work which in so many other states has had a different issue.

NORDENSKIÖLD'S ARCTIC INVESTIGATIONS.

WHEN Baron Nordenskiöld retired in April, 1882, from the presidency of the Royal academy of sciences at Stockholm, he took for the subject of his address the story of the Zeni brothers. This address was published in Swedish in 1883; and in the same year he laid before the Congrès des Américanistes, at their session at Copenhagen, three of the early maps, illustrative, as he thought, of an early acquaintance with Greenland, posterior to the so-called Northman discovery in the tenth century, and earlier than the period of Columbus. These were the Zeni map of 1380 (1390?); a map of 1427, found in a manuscript of Ptolemy at Nancy; and the Donis map of the edition of Ptolemy, printed at Ulm in 1482. In the German version of Nordenskiöld's papers, which has recently appeared as 'Studien und forschungen,' we have this same Zeni study in a language easier read by most inquirers. Those who believe in the substantial truth of the Zeni narrative will find Nordenskiöld on their side. He identifies the Frisland of the story with the Faröe Islands, makes the Zeni to have reached Greenland, and identifies the Estotiland and Drogeo of the Frisland fisherman with our American coast from Newfoundland south.

The botanical portion of the book has been contributed by three writers, — Nathorst, Kjellman, and Wittrock, — who treat respectively of the former botanical geography of high latitudes as indicated by the results of polar research, the biology of the arctic flora, and the vegetable life of the naked snow and ice. All of these articles are remarkably free from technicality, and form pleasant and instructive reading, the last being especially valuable because of its full references to the literature of the subject.

Fossil collections made from time to time in the arctic region, and, for the most part, elaborated by Heer, when compared among themselves, and with similar collections from Europe, show a remarkable uniformity in the early flora of the entire northern part of the world, until, scattered and driven southward along numerous lines of migration, it has left its descendants mainly on the eastern sides of the two great continents, as Dr. Gray has already shown in his history of Sequoia.

For the most part, the present arctic flora is composed of the descendants of tertiary alpine species, which, wandering from their original homes, — the Alps, the mountains of Greenland and Scandinavia, the Caucasus, and the Altai and Rocky mountains, — were driven back, at the end of the glacial period, to high elevations, or into the circumpolar region, by the warmer climate which succeeded. The collections made by the returning Vega party at Mogi, in Japan, are interesting because they indicate a certain, though relatively slight, reduction in temperature in that part of Asia corresponding to the glaciation of America and Europe, though, as is well known, no traces of inland ice occur there.

The arctic flora of to-day is a most interesting subject for study. While the ocean, at a short distance from shore, supports a growth of giant kelps and dark Florideae, which manifest continued activity the year through, vegetating in the short summer, and pushing their reproductive processes during the long winter night, the land-plants are all pygmies, apparently less because they cannot endure the intense cold of winter, than because they do not enjoy sufficient warmth in summer to assimilate enough organic matter for any considerable growth.

In a region where the average daily temperature for the least cold month of summer is but a few degrees above the freezing-point, and where vegetation is practically limited to about two months of even this slight warmth, interesting adaptations are met with on every hand. Annuals are as good as unknown, the season proving too short for the development of their vegetative organs, and the subsequent maturation of fruit. The entire flora is practically biennial or perennial; the plants rapidly pushing into bloom, like our spring flora, with the first abatement of the cold of winter, yet, unlike the latter, barely fruiting, and elaborating material for the next year's flowers before the short summer is succeeded by another winter. Indeed, the season is too short for the majority of even these precocious and hardy plants, many of which are forced to rely on vegetative reproduction except in the most favored situations, while nearly all are caught in the midst of flowering by the cold of autumn, which

Studien und forschungen veranlasst durch meine reisen im hohen norden. Von A. E. NORDENSKIÖLD. Autoriste ausgabe. Leipzig, *Brockhaus*, 1885. 9+521 p., illustr., 8 pl., and maps. 8°.