subordinate member of the Serra do Mar system (the Serra da Bocaina, or Quebra Cangalha), which, being intercalated between the maritime range and the Serra da Mantiqueira, impels the river to the south, until, escaping around the end of this barrier, it encounters another in the Mantiqueira, which forces it northward until it finds a passage across the Serra do Mar, and escapes to the sea. The Iguape, or Ribeira, in southern São Paulo, with its northern tributary the Juquiá, reveals the same fact of the splitting-up of the maritime range into distinct ridges.

O. A. DERBY.

IRVING ON THE COPPER-BEARING ROCKS OF LAKE SUPERIOR.

IN his opening chapter, Professor Irving gives a succinct history of the earlier investigations of the copper-bearing rocks of Lake Superior, a clear exposition of the views that have been held respecting them, and a full bibliography of his subject. The discussion proper is introduced by a sketch of the extent and leading characters of the formation, illustrated by an excellent map. This is the first really synoptical view of the series, in any thing like its regional entirety, that has been presented.

Instead of a mere local phase of some well-known geological horizon, it is described as a unique formation of consistent characters and enormous thickness, stretching out to an ascertained length of five hundred miles, with a width of a hundred miles, and an area, excluding the Nipigon extension in Canada, of forty-one thousand square miles, — nearly two-thirds the size of New England. "Throughout this wide extent, though local peculiarities are to be noted, the general characteristics of the group are wonderfully constant." It consists of an enormous series of eruptive sheets, — lava overflows in the main, — among which are intercalated beds of sandstones and conglomerates, and over which lies a great thickness (fifteen thousand feet) of detrital material, making a total pile of forty thousand feet.

A careful description of these rocks next follows, illustrated by very fine microscopic sections, and conveniently summarized in tables. The studies of Professor Irving do not add greatly to the kinds of basic rock previously described by Professor Pumpelly in the reports of Michigan and Wisconsin; viz., diabases, malaphyrs, and gabbros. He has, however, amplified the varieties and the geographical distribution of these, and added an interesting anorthite rock. To the acid eruptives he has made a more notable contribution in determining not only the presence, which was partially known before, but the important development of quartzless porphyries, quartziferous porphyries, felsites, augite syenites, granitells, and granites. He shows that these are, at the same time, members of the original eruptives, and chief contributors to the detrital beds, especially the conglomerates. But more completely new and theoretically important is the recognition of a class of intermediate rocks (silica from fifty-two to sixty per cent) which constitute phases of the orthoclase, uralitic, and hornblende gabbros, and of the diabases, diabase porphyries, and their amygdaloidal forms. The detrital rocks are conglomerates and sandstones, with shaly phases. They are chiefly derived from the acid eruptives, though where closely associated with basic rocks, a large element is derived from these. In some parts a notable contribution has been made by the older crystalline rocks.

The lithological discussions are critical, and evince a familiarity with the latest phases of this rapidly developing branch of study. They embrace a hundred and eighteen pages.

Following this are nearly two hundred pages devoted to the stratigraphy of the series. The author maintains with justness, that the igneous beds, being overflow sheets, are fully amenable to the common laws of stratigraphy; and his discussion is notably free from the license of eruptive geology. He brings together for the first time, from his own and others' observations, specific descriptions of the formation from all sides of the Lake-Superior basin. It is to be hoped that in this he inaugurates a new era in the discussion of Lake-Superior geology, in which the study of its problems shall be cosmopolitan, in distinction from that narrow provincialism or that distant unfamiliarity which has so largely vexed their past history. Professor Irving's descriptions necessarily fall much short of full completeness; but they constitute a great advance in the endeavor to give, by precise descriptions, maps, and sections, an approximately accurate conception of the entire formation, so far as displayed in the Superior region. Completeness will only be approached when it is possible to extend over the whole region such excellent detail work as that of Pumpelly and Marvine in Michigan, and the author himself in Wisconsin.

The eighth chapter of the monograph is devoted to the relations of the Keweenaw series to the associated formations, and traverses the ground which has been most contested in Lake-

Monographs of the U.S. geological survey. Vol. v. The copper-bearing rocks of Lake Superior. By ROLAND DUER IRVING. Washington, *Government*, 1883. 16+464 p., 29 pl., 37 figs. 4°.

Superior geology. To the class of formations later than the Keweenawan, he refers the fossiliferous Cambrian sandstone of the Mississippi valley, and the horizontal sandstones of the Superior basin, known in local geology as the 'eastern' and 'western' sandstones. To the series of older formations he refers the Animikie group, the original Huronian, and the Penokee, Marquette, and Menominee Huronian groups. The fossiliferous sandstone of the Mississippi valley (Potsdam) he confidently considers later than the Keweenaw series, because it unconformably overlies it, with evidence of great intervening erosion. The 'eastern' and 'western' sandstones also are held to be newer, because they adjoin the Keweenaw series by unconformable contacts associated with fault-lines. These three sandstones he refers to essentially the same horizon, — the Potsdam, or its immediate downward continuation. In support of these views, he cites a large array of specific evidence, and gives precision to his discussion by maps and diagrams. The older formations named are separated from the Keweenawan on the grounds of unconformable relations, and discordance of character.

The stratigraphical discussion is fittingly closed by a sketch of the Lake-Superior synclinal. The existence of a downward flexure embracing the western part of the basin was long since made known by Foster and Whitney. Professor Irving and his Wisconsin colleagues, a few years since, determined its south-westerly extension into the borders of the Mississippi basin. The author now makes an important extension eastward so as to embrace nearly all of the lake's area, the trough assuming a curved, rudely reniform contour.

The monograph is closed by a chapter on the copper deposits, which were, however, not special subjects of investigation.

The treatment throughout is candid and able. There is a close adherence to facts, and the conclusions that legitimately flow from them. The memoir is a valuable contribution to general geology. The horizon of which it treats has long lain under a cloud of obscurity, if not of actual chaos, in Europe as well as in America. The distinct differentiation of the formations of one important field cannot fail to aid in the study of all others. When equally explicit descriptions of other regions involving this horizon shall be at command, we shall doubtless be on the threshold of agreement as to its taxonomic place and value. Present disagreement is largely an expression of imperfect knowledge and provincial study.

WORLD-STUFF.

'Whence came this world?' and 'Whither is it going?' are questions of never-tiring interest to mankind, — questions upon which they have pondered for long ages, and which are still unsolved. Where is the man who, without a shudder, can turn from the beautiful life around him, and in fancy contemplate a cold, cheerless, dark, lifeless condition of the world towards which we have every reason to believe it is tending?

In the book before us we have an effort made to weave the various speculations of others, regarding the evolution of the universe, into a continuous and harmonious whole by an admixture of the author's own ideas. Professor Winchell is well known from his past efforts to popularize science, and for his speculative tendencies; and perhaps he, of all American writers, is best fitted to popularize a subject like the one he has chosen, and commend it to the interest and attention of the masses. The work is to be judged rather by its success or failure as a popular presentation of the subject, than as an original contribution to cosmical science. In either respect, the book is disappointing; for our author, instead of keeping in a field in which he has perhaps no superior in America, has attempted a middle ground. He has written so that his treatise occupies a higher plane as a scientific treatise than his previous books, although, as is the tendency of all speculative minds, the presentation of theories has been mistaken for the presentation of evidence and proof. Again: as a popular presentation of the subject, the work falls below the other books of the author, so far as we are acquainted with them, and doubtless many portions will be considered by its readers as dry and pedantic. On the other hand, the work shows in many parts a mode of presentation of certain difficult questions that is well worthy the careful study of the majority of our scientific writers who have any desire that their readers should understand what they are writing about.

The author holds that the dust and iron globules found in the depths of the sea and on the mountain-tops are of meteoric origin, — a veritable world-stuff, pervading all space, — and that by and from this stuff world-systems are evolved. He supposes that a tendency for immense amounts of these dust particles to associate about a common centre leads to the formation of nebulous clouds, which, from a

World-life; or, Comparative geology. By Alexander Winchell, LL.D., professor of geology and paleontology in the University of Michigan. Chicago, *Griggs*, 1883. 21+642 p. 12°.