in accordance with the reflex innervation, if we may call it such, for adjustment. But we shall not enter upon this in our present problem. We have mainly to notice that *a* and *c* will not fuse while the latter, *c*, can fuse with *b*. Now, as no greater degree of convergence is required for the combination of *b* and *c* than for *A* and *B*, their combined image will appear in the same plane as that of *A* and *B*. This is of course relatively a monocular localization. But, singularly enough, there is a binocular effort, as it were, in one eye, to combine *a* with *c*; and the result is that *a* appears nearer the observer than the combined image of *A* and *B*, without in the least translocating the fused image of *b* and *c* from their position in the plane of *A* and *B*, and without separating them to produce any fusion of *a* and *c*, although the latter can be effected if we will. Rivalry will at times suppress the translocated image of *a*, so that it appears monocularly located in the same plane with *b* and *c*, or *A* and *B*. The alternations may be very distinctly observed. But here we have a very evident case of binocular innervation in one eye, and localization of *a* in accordance with it nearer the observer; while no such binocular translocation and innervation take place for the fused image of *b* and *c*, because it preserves a constant relation to that of *A* and *B*. *b* and *c* sustain the same relations of distance to the median plane, and hence will be monocularly localized in the same position of the third dimension as *A* and *B*, although binocularly combined. Whatever of tension or innervation there may be in the left eye for binocular combination of *c* with *a* is counteracted by the opposite tension to retain the fusion of *b* and *c*, which remains located in the plane of *A* and *B*, or, better, of their fused image. Thus there is left only the binocular innervation of the right eye to translocate the image of *a* to a position nearer the observer than the other images, except when this tension is suppressed by rivalry. Then *a* is located at the same distance as the others. The incident is interesting as showing that there may be rivalry between binocular and monocular functions for localization in the *third* dimension as well as the ordinary rivalry between colors in plane dimension. It confirms also the results of the first experiment we have described.

We have presented these phenomena to suggest the possibility that monocular influences, apparent in the instances noted, may account for many irregularities and illusions in binocular vision as practised by the experimenter to investigate localization. Why may not rivalry between them suppress certain impressions, so that the effect may appear to be different from what it really is? Why may it not account for the failure of stereoscopic combination of two real objects to translocate their fused image to the point of fixation? We do not insist that our explanation must be correct: nor will too great stress be laid upon our conjectures without some verification from the experience of others. To our experience there seems no other way of looking at the matter.

J. H. HYSLOP.

Baltimore, Md., Jan. 31.

Transcontinental Railroads.

IN treating the subject of transcontinental railways, *Science* (x. No. 241) uses language to the effect that the Cascade Range of Oregon and Washington is known to be a continuation of the Sierra Nevada, and mentioning as a striking and all-important structural difference that the Cascades are volcanic, while the Sierra is granitic, therein assuming as facts two propositions which have been much debated, but which, in the present state of geological knowledge, can hardly be demonstrated. In order to learn the progress of opinion respecting the connection of the two ranges, readers of *Science* should consult the *American Journal of Sciences*, third series, vol. vii. p. 177, wherein Prof. Joseph LeConte suggests the idea, original with himself I believe, of the unity of the two ranges in age and cause.

Second, Clarence King, in 'Geology of the 40th Parallel,' pp. 441–454, extending theory far beyond the support of adequate observation, held that the Cascades were separated in age from the older Sierra by a vast time-interval (to wit, the whole of the cretaceous period), and that the Blue Mountains of eastern Oregon were the real continuation of the Sierra.

Third, Dr. Becker of the United States Geological Survey, basing his opinion on the finding of granitic and metamorphic rocks in the cañon of the Umpqua River in the southern Cascades, remarks (see Bulletin 19, United States Geological Survey) that that portion of the range has a foundation similar to the California ranges, and is probably due to the same upheaval. He thus maintains a proper reserve as to the general question.

Lastly, Mr. Diller (Bulletin 33, United States Geological Survey), after examining the stratigraphical relations of the Cascades, Sierra, and Coast Range at their presumed point of divergence in northern California, while quoting Dr. Becker's discovery and opinion, sums up his own conclusions thus: "As far as is definitely known, the Cascade Range was not represented by a ridge of older metamorphic rocks which were folded and upheaved at the same time with the Sierra and the older portion of the Coast Range, and *is entirely distinct from them in structure and origin.*" In another connection he says, "Such rocks [granitic and metamorphic] make up the Coast Range west of Mount Shasta, and it may be that they form an elevated foundation for the Cascades between Rogue River and Mount Hood; but this is rendered less probable by the complete section along the Columbia River, where the range is cut across nearly to sea-level, showing, according to Professor LeConte, that it is made up almost wholly of recent lavas resting on undisturbed miocene strata." Mr. Diller, of his own observation, announces that the Cascades, where intersected by the Klamath River, are also composed exclusively of recent eruptive rocks. Thus the matter stands to-day, and it is doubtful if the question of a simultaneous origin is to be settled on other than paleontological grounds, by a careful and minute comparison of fossil evidences.

The second assumption, that the two ranges differ in the one being granitic, the other volcanic, I dare say, is but the reflection of the common belief which took its rise from the circumstance of the only known or visited section, that of the Columbia gorge, being entirely volcanic, but is nevertheless a most indiscriminating and erroneous opinion, as I will endeavor to show.

I find that the drift brought down by the ancient glaciers of the Cascades, and deposited in the valleys below, invariably contains a proportion, though very variable, of granitic and sedimentary bowlders. In some cases, particularly of certain ice-streams which flowed into the Willamette valley (which, by the way, is covered for the most part with glacial *débris* to a great depth), the granite and metamorphic bowlders and gravel predominate immensely; sometimes, indeed, to the exclusion of volcanic sorts. The prevailing types in most other drift localities, however, are volcanic. The significance is that a part of the rock-masses eroded by the ancient glaciers were granitic and metamorphic beyond a doubt; and, in the cases where transported bowlders prevail, the parent granitic and metamorphic rock-masses from which they were derived must have preponderated over the volcanic masses. I leave the question of the comparative erodibility of the various rock-masses, as well as the considerations arising from their relative positions, all of which must have had influence on the proportions of granitic, metamorphic, and volcanic glaciated bowlders.

But we need not depend upon the accidental evidences of extinct glacial action to prove the composition of the Cascades, for examinations of the range at different points have shown me that it is not exclusively volcanic by any means; indeed, I doubt much if the granitic and metamorphic rocks do not preponderate over the volcanic rocks, viewing the range as a whole. Judging by the evidence of formations *in situ*, I should say, notwithstanding the existence of exclusively volcanic sections, that the foundation of the range in general is not unlike that of the Sierra, excepting that I see no indication of the great orographic blocks which, according to Mr. Diller, compose the northern Sierra.

Judging from what has been published concerning the range, the prevailing idea of its structure seems to regard it as composed of a single anticlinal ridge composed wholly of basalt, and crowned with snow-covered conical peaks set at regular distances along the range. Geologists who have this idea will be surprised to learn that granite appears in the range at an altitude of two thousand feet, within eight miles of the Columbia. This is on the north side of the river; while on the south, towards Mount Hood, it is said to be found at five thousand feet. I cite only the former instance as observed by myself. I also find granite on the Santiam River at a height of five thousand feet above sea-level, and on the McKenzie

at twenty-five hundred, it forming the bed of the latter stream for twenty miles.

One of the most interesting portions of the Cascade Range is the region of the Santiam River, in latitude 44° 45′ north, — a tributary of the Willamette. The lower foot-hills there are composed of a yellowish volcanic ash, stratified in part, and which reaches a thickness of several hundred feet. Such deposits are very abundant on the western slope of the range, amply fulfilling Mr. King's acute prediction of their existence (see 'Survey of the 40th Parallel,' vol. i. p. 453). The ash rests upon basalt, which lies in thick layers conforming to the general westward slope of the range. As we advance into the mountains, the basalt thins out, and at a moderate elevation disappears entirely in its general form of surface outflows, and is seen only as scattered dikes penetrating older rocks. Undoubtedly the basalt rests, as a rule, upon the unaltered sedimentary rocks to be referred to in another connection; but I have not observed them at the precise locality of which I speak. At an altitude of perhaps one thousand feet, the later rocks are replaced in the bed of the stream by metamorphic rocks of a slaty texture, which appear to dip westward. Proceeding up stream, and approaching the axis of the range, we find in very deep cañons some excellent exposures which illustrate the geological structure in a most remarkable and cogent way. The cañons are clearly of glacial origin, and are cut down three thousand feet or more through rocks of various ages, the lowest ones visible being metamorphic slates similar in all respects to the auriferous slates of California, — a resemblance that is heightened by the fact that the Santiam slates are also auriferous, workable quartz veins existing therein. The slates are nearly vertical, with a slight westerly dip. Upon them rest unconformably a great thickness of clayey and sandy shales, and conglomerates, unaltered, and of course devoid of quartz veins, and occupying a nearly horizontal position in general. They are cut by deep cañons into great mountain-masses, and form probably the most important division of rocks at this part of the range. I should judge them to be fully two thousand feet thick, and perhaps three thousand. I have secured no fossils from which their age might be determined, but for statigraphical reasons, with which I will not trouble *Science*, I shall denote the terrane as cretaceous until its age be more satisfactorily determined. I am not aware of any description of this formation having ever been published, nor have I ever heard or read aught concerning it.

Of later sedimentary rocks, the only existing ones yet discovered are certain fossiliferous sandstones and associated shell limestones, which have been spoken of as miocene, and may well belong to that system. They appear in the Cascades as fossil sea-beaches, defining the limits of the miocene ocean. The maximum height at which I have noticed these rocks in the Santiam region is between eight hundred and a thousand feet.

As might be supposed, the metamorphic slates rest against granite, which here forms the backbone of the range, the upper central portions being entirely composed of it and slate, plus a proportion of recent lava, which seems to have come from crater eruptions, but of which I can say little. I desire to call attention to the prevalence of ancient lavas in contradistinction to the more modern basaltic flows. There are heavy bodies of probably augitic lava overlaid by and therefore older than the rocks I have denominated cretaceous. Other instances seem to prove associated lavas as old as the auriferous slates. Of these eruptive rocks, I recognize two or three general types, which I have forwarded for study and determination to Professor Jackson, the petrologist at Berkeley, Cal. Altogether, I believe that the eruptives, old and new, make up perhaps one-eighth or one-tenth of the bulk of the visible terranes of the Santiam.

It is evident that the Santiam section resembles neither the exclusively volcanic exposures cited, nor the Umpqua section, as described by Dr. Becker, who found granite and metamorphic rocks overlaid unconformably by miocene strata, without the presence of intermediate unaltered rocks. Besides, his metamorphic types were chiefly serpentine, which, notwithstanding its immense development in southern Oregon, I have not noticed north of the Calapooia Mountains. It seems not improbable that the serpentines may be the representatives of the unaltered shales and conglomerates of the Santiam.

From the above observations, and from other reasons which I will not take space to explain, I conjecture that the earliest mountain-making movement which affected the Cascades took place much farther back than the cretaceous, as held by some, and resulted in forcing up the granite nucleus, with its covering of slate or the representatives of slate, to a considerable height above sea-level; this movement being followed by extensive denudation, of which good evidence appears to exist. Then followed a submergence, total or partial, when the strata that I call cretaceous were laid down. The whole range could hardly have been ingulfed at the time, for I am told of tracts now existing where no intermediate strata are found between the early granite and the late basalt. I can suggest nothing as to the condition of affairs during the eocene time, the question of the existence of marine strata of that age in Oregon not having received attention.

It would seem that the miocene strata were deposited on rising areas, when the Cascades had reached to within a few hundred feet of their present height.

It is probable that there have been at least two upheavals, and one movement of subsidence, which, with attendant phenomena, I have grouped as follows: —

1. In paleozoic or early mesozoic time, primary elevation of granite axis with overlying sediments, accompanied by metamorphism of the latter.

1*a*. Denudation of range.

2. Subsidence beneath cretaceous sea, and deposition of cretaceous strata.

3. Elevation to within one thousand feet of present state.

3*a*. Deposition of miocene rocks.

3*b*. Outpouring of lavas through fissures.

3*c*. Era of crater eruptions, and deposition of beds of volcanic tuffs in late seas and lakes.

3*d*. Continued elevation of land to present height, accompanied by glacial and aqueous erosion. Diminished volcanic activity.

There are certain evidences, among them Captain Dutton's discovery of a rising surface at the Cascades of the Columbia, which make it probable that the mountain-making movements are still going on in the range.

HERBERT LANG.

Portland, Ore., Jan. 31.

Queries.

27. WASHINGTON'S LETTERS. — In the last number of the *Magazine of American History* there are two letters of Washington which I think are of doubtful authenticity. The first letter is printed on p. 162: the second immediately follows it. Both are claimed to be taken from originals in the collection of Dr. Thomas Addis Emmet. That forgeries are extant of Washington's letters, is well known to collectors. One prominent test of such forgeries is said to be in the autograph. Washington always abbreviated 'George' by writing 'G°,' and never used the initial *G* alone. Such a test, if reliable, applied to the letters, would prove them to be forgeries. This test will hold good in comparing the undoubtedly genuine letters copied from originals in the British Museum, and printed in the same number of the magazine. Again, the subject-matter of these letters is suspicious, especially where Washington is made to write of his troops at Cambridge, that they "are an *exceedingly dirty and nasty people*." I do not claim to be an expert on such matters. On the contrary, my disbelief in their authenticity is based more upon my wish that our beloved Washington did not write such a sentiment.

GEORGE GLENN WOOD, M.D.

Muncy, Penn., Feb. 7.

Answers.

23. DROPS OF WATER. — In answer to Mr. E. J. Pond's query in relation to floating drops of water upon the general surface (*Science*, xi. p. 38), I beg leave to refer him to the paper of Prof. Osborne Reynolds of Manchester (England), published in *Nature*, vol. xxv. p. 23, Nov. 3, 1881, where he will find an explanation of this capillary-film phenomenon, as well as a clear indication of the physical conditions necessary for its production.

JOHN LE CONTE.

Berkeley, Cal., Jan. 30.