10° to 46°. Of these constants only those at the extreme limits of temperature vary from the 2–3 limit set for the chemical reaction constant. As to his own experiments on dogs, Herlitzka studied but few hearts, and these apparently from dogs of all sizes and weights, and compares results of hearts in apparently all stages of nutrition, age, size and state of injury. He then comes to this conclusion (p. 286):

2°. L'aumento della frequenza delle contrazioni cardiache non è una funzione costante della temperatura, ma varia da un cuore all' altro ed anche nello stesso cuore in varie fasi dell'esperimento. A volte si tratto di una funzione lineare; raramente e mai completamente la frequenza seque la legge a cui soggiaciano le comuni reazioni chimiche, gli enzimi, l'accrescimento ecc.

As to what value should be placed upon this author's work and his conclusions, this must be left to the decision of the intelligent reader.

In the paper already referred to the writer has shown from Martin's results that the dog heart obeys the law for chemical reactions as closely as if one were dealing with pure chemicals. Not only when studied statistically, then, but also when the individual heart of the mammal is studied, is this found to be the case. The same relation was shown to hold for the rabbit heart and, in an unexpected way, also for the human heart.

While the thesis seems to be proved beyond doubt the writer will be pardoned if he adds still other evidence.

Baxt[3] studied the effect of temperature upon the dog heart primarily to find out the influence of temperature upon the action of the vagus and accelerens nerves. But in recording his results he always put down the temperature and rate of the heart before stimulation. So it happens we have in his paper considerable data for further study of the temperature coefficient of the 'normal' heart of the dog. Under the conditions of his experiment the temperature of the animals had a tendency to fall off. By surrounding the dogs with a double-wall chamber in which water circulated the temperature could be lowered and increased at will. Dogs of middle weight and in good condition were selected for the experiments. The hearts were left intact in the body, and artificial respiration was maintained, the animals being poisoned with curare. The temperature was varied between 27.15° and 42.8° C.

Wherever a number of observations were made, at about the same time, of temperature and rates of very nearly the same value, the writer determined averages for them. These averages were compared with rates at lower or higher temperatures and their coefficients interpolated by the formula, $10R_1/R_2(t_1 - t_2)$, where R_1 and R_2 are rates at the corresponding higher and lower temperatures, t_1 and t_2. These coefficients are: (1) From pages 339–340, for 'A'—2.18, 2.3, 2.0; for 'B'—2.3, 2.7. (2) From page 341, for 'A'—2.2, 2.6; for 'B'—2.5, 2.0, 4.3, 3.1, 3.6, 4.0. (3) From page 342, for 'A'—2.2, 2.0, 3.1, 2.5, 3.1, 2.6, 2.4, 3.9; for 'B'—1.7, 2.6, 2.7, 2.2, 2.2, 2.8, 2.6, 2.5. (4) From page 356—1.2, 1.8, 2.5, 2.5, 2.0 1.7, 2.4, 2.6.

Of the individual coefficients shown above the lowest is 1.2, the highest 4.3; 71 per cent. of them range between 2 and 3. The mean average is 2.43. Verily, the mammalian heart does follow the law for a chemical reaction velocity as influenced by temperature.

CHARLES D. SNYDER

BERLIN,

[3] Baxt, *Berichte d. K. Sächsischen Gesellschaft der Wissenschaft*, Leipzig, Math. physik. classe, 1875.

THE FLANKING DETRITAL SLOPES OF THE MOUNTAINS OF THE SOUTHWEST

General Aspect and Grade of Detrital Slopes.—The attention of travelers in the southwestern portion of the United States is arrested by the long and regular slopes of gentle grade flanking the rocky ridges of the mountains, and stretching in unbroken lines, often for ten or twenty miles, across the line of vision. Such slopes are most distinctly developed in the Great Basin of Nevada and the semi-desert Piedmont region of Arizona. They give a striking and unique character to the scenery, producing upon the beholder the impression that the wide ocean must have been the agent causing such sweeping outlines and regularly inclined surfaces.

The great table lands, or plateaus, so-called, of the Great Basin region are, in fact, a series of long slopes and not tabular surfaces. This is most notable in the southern portions of the basin, where the general surface is inclined from an altitude of about 4,000 feet downward to the sea-level, and even below that level, as at Death Valley, Nevada. The bordering mountains, and each detached mountain ridge or peak in that region, known as 'Lost Mountains,' are flanked by detrital accumulations from the high rocky ridges.

A fine example of a flanking slope is found on the north side of San Bernardino Mountain, California, extending from the summit of the Cajon Pass to the Mohave River, a distance of 19 miles, with a grade, or ascent, of about 105 feet per mile. It is traversed by the old Spanish Trail and seems like a plain to the traveler when riding in a Pullman car.

In the region of Tucson, Arizona, there are fine examples of long slopes of great regularity flanking the Santa Catalina Mountains, the Santa Ritas and the Sierritas.

The length downward of the Santa Catalina slope on the south side, measured from the 3,500-foot contour down to the Rillito, or to the 2,500-foot contour, is five miles, and the difference of elevation is 1,000 feet, giving a fall of 200 feet to the mile. This slope may be regarded as the upper portion of the former slope, the lower portion having been swept away by the Rillito and Santa Cruz drainage. If, as we may believe, the slope originally extended as far as the Santa Cruz River, or ten miles in length, the average fall would be 100 feet per mile, thus agreeing with the grade at the Sierritas Slope, and at the Santa Rita western slope.

This western flanking slope of the Santa Rita mountains is a good example of the regularity of descent, and of continuity. From the 4,000-foot contour near McCleary's camp down to the 3,000-foot contour above the Santa Cruz river, the distance is eight miles, and the fall is 1,000 feet, or about 125 feet to the mile; but if the lower portion of this slope had not been cut away by the river the length would be ten miles, and the average grade 100 feet to the mile.

The slope of the Sierritas range, southeast of Tucson, is remarkable for its average grade of about 100 feet to the mile for the distance of ten miles. The grade increases nearer the mountains in this as in other examples.

The north side slope of the same range is equally or more remarkable for its extent and even grade.

The valley of the Sonoita from Calabasas eastwards to the summit affords fine examples of the ancient slopes and their deep erosion by the river, leaving terraced banks.

Origin of Detrital Slopes.—The form and origin of detrital slopes, especially those of the southern portion of the Great Basin, are discussed in my report of Explorations in 1853.[1] The broad general molding of the slopes by oceanic action is there recognized as, also, the present modifying action of streams and flood-waters, which are described as spreading out over the lower portions of the slopes 'fan-like' in a multitude of channels, but at lower levels than the upper portions of the slopes which are cut through and left high above the existing stream. Such slopes are in strong contrast with the localized phenomena of modern deltaic detrital deposits at the mouths of mountain gorges or canyons, known as 'alluvial fans' or 'alluvial cones.' While doubtless such delta-like deposits, and the long slopes, have initially the same origin in this respect, at least, that all are made up of débris from the high rocky ridges; the flanking slopes to which I wish to direct attention are less localized, are without the deltaic form, are much more extensive and broader, and are generally without evident relation to any particular canyon or gorge of the mountain, and do not exhibit the scalloped outline of intersection claimed for alluvial fans. They show the operation of a widely extended distributing or leveling agency which it would appear could not have been other than tides, waves

[1] 'Report of a Geological Reconnaissance in California,' 1855, pp. 214–217.

and currents of the ocean during submergence of the land.

But these views of the subaqueous distribution of the detritus have not found favor and are not accepted. The consensus of geologic opinion appears to be that the slopes are wholly subaerial in origin; the result of stream action and distribution alone, without oceanic aid. Their continuity is explained by Gilbert and others, by their contiguity and the coalescence of many adjoining alluvial cones, each with its apex at the mouth of a gorge or a canyon, producing about the mouth of such gorge a symmetric heap of alluvium. Gilbert writes:

> Rarely these cones stand so far apart as to be completely individual and distinct, but usually the parent gorges are so thickly set along the mountain front that the cones are more or less united, and give to the contour of the mountain base a scalloped outline.

This view was accepted by Russell, who quotes it in his paper, in the *Geological Magazine*.[2]

It is accepted also, by Geikie, Dana and others.

In geological literature the slopes are usually described as alluvial fans, alluvial cones, or talus fans. We are indebted for most of these terms to Dr. Drew, who, describing the alluvial and lacustrine deposits and glacial records of the Upper Indus Basin, uses the terms 'fan talus' and 'alluvial fans' for the detrital accumulations at the mouths of canyons. In the illustrations these accumulations of detrital material are represented as local and very steep in inclination, with radii perhaps a mile in length. The 'amalgamation' or union of fans is recognized, and examples are given of the denudation of fan slopes.[3]

Dr. Ida H. Ogilvie, describing the topography of the Ortiz Laccolith in New Mexico, proposes the name 'conoplain' because of the outward slope of the surface in all directions. This sloping[4] surface is regarded as the result of subaerial stream action, under substantially present conditions, and it is suggested that the broad areas of the great plateaus have been produced by a similar process.

Evidences of Submergence.—The great dominant fact showing that the slopes in their original integrity of form were deposited and shaped during submergence, and that they were molded by oceanic currents, rather than by the waters such as now exist, is that the slopes, or the portions to which I refer, are older than the streams. They antedate the streams and the valleys of the existing drainage. The conditions under which the continuous higher slopes were formed are obviously very different from those now existing. The action of the streams of the present is one of redistribution of the material of the slopes. It is destructive of the higher and older slopes, and not upbuilding or constructive except at lower levels of deposition. It is true that the materials of portions of the slope are carried downwards and onwards and are deposited at lower levels, where the volume of water is diminished by wider distribution and by absorption. We thus have what may be called primary and secondary slopes or, if preferable, initial and derived slopes. The secondary slopes, now forming, are in washes and arroyos below the surface of the primary slopes, remnants of which are left on each side sufficient to preserve the grand topographic features and scenic effects far above the reach of modern floods. The higher parts of the flanking slopes do not to-day receive accessions from the canyons, they are not being built higher and are not the product of modern streams. The conditions of deposition were evidently very different from those of to-day. The phenomena all point to the formation of the primary slopes during a period of subsidence before the great Post-Miocene continental uplift. The amplitude of this movement was doubtless greater than is indicated by the height of the initial slopes.

Generally throughout the southwest, the upper margin of the slopes is between the

[2] *Geological Magazine*, N. S., Decade III., Vol. VI., No. VII., July, 1889, p. 290.

[3] Frederic Drew, Esq., LL.D., F.G.S., *Quarterly Journal*, Geological Society of London, 1873, p. 441.

[4] *American Geologist*, Vol. XXXVI., July, 1905.

3,000 and 5,000-foot contour line. The upper margin of the slopes of the mountains of the southern part of the Great Basin has an average height of 3,466 feet, the mean of the height at eight different localities ranging from 3,000 to 4,000 feet.

The Santa Catalina range of mountains north of Tucson affords an excellent example, especially along the south side, where, for a distance of nearly fifteen miles, the slope commences at the base of the cliffs at about the contour line of 3,000 feet. The change of the topography may be followed by the eye. It has the semblance by its horizontality of a beach line or old shore line, but the usual characteristics of an old beach or ocean border, such as shingle and upright sea-wrought cliffs, are wanting, having probably been obliterated by long-continued weathering. The same contour line of 3,500 feet may be followed similarly around the western point of the range to the north side. In other words, the 3,500-foot contour line follows approximately the beginning of the rocky outcrops above and of the slopes below. From this elevation up to 4,000 feet appears to have been the height of the old ocean level for a long time. It can not yet be fixed with precision. Careful search along this general level may result in finding unequivocal evidence of the former level of the sea. In the Huachuca Mountains the upper margin of the slopes is higher, being nearer the 5,000-foot contour than the 3,000-foot.

We do not find along the Catalina range, a distinctly scalloped outline of intersection of the slope with the higher ridges. The slope is very even and regular in its continuity and in the approximate parallelism of the contour lines, broken only by the arroyos or channels of modern drainage, leaving remnants of the former slope on each side. The same observation applies to the slopes bordering the Santa Rita and other ranges north and south of Tucson. These conditions are well illustrated by the contour lines on the map by the U. S. Geological Survey of the Tucson and Santa Rita quadrangles to which reference is made.

Slopes Older than Existing Drainage.—That these ancient detrital slopes are older than the present streams and watercourses is made more evident and in a striking manner by the fact that existing streams and valleys cut across the slopes at right angles to their line of descent, in some instances bisecting the slopes as on the San Pedro River, between its junction with the Gila river and the town of Mammoth. One part of the long slope from the Catalinas is found on one side of the stream, and another portion on the opposite side.

The slope of the southern side of the Santa Catalina, a few miles north of Tucson, is cut across for miles at right angles to its southward descent by the east and west stream, known as the Rillito, which has left an abrupt bank on its north or right bank, a truncation of the slope, while on the south side or left bank we find upon the 'mesa' the coarse detrital deposits characteristic of the 'wash' or slopes of the Catalinas. It is clear that these deposits were once continuous and that they were laid down before the Rillito valley was cut out. Semi-rounded blocks of large size, a foot or more in diameter, of the peculiar augen-gneiss of the Catalina ridges, and horizontal beds of gravel and sand from the mountains are found in digging the wells of the mesa south of the Rillito. Obviously this distinctly detrital slope was formerly unbroken in its extension to the Santa Cruz, and was formed before the Rillito valley, which has been cut out of the slope by the river.

Similar conditions are found farther south where the Santa Cruz River cuts across the lower portion of the slope from the Santa Rita mountains, north and south of Tubac. The cutting out of this valley leaves a steep bluff-like ending of the long regular slope. This also has many deep arroyos parallel to the line of descent, which show the rude stratification of the detrital materials of the slope, portions of which are soft and clay-like, apparently deposited under water. In some sections, the stratification is very regular and horizontal. The portions of the ancient slope left between the arroyos have practically the same angle of descent and the same elevation and are clearly remnants of a once continuous slope or inclined plane.

Antiquity of the Slopes.—In further support of the view of the great geological antiquity or Tertiary age of the initial slopes, reference may be made to the high auriferous gravels of the Sierra Nevada of California, which probably were coincident in formation. Like the ancient detrital slopes of Arizona, they are cut through in all directions by existing rivers. Their great antiquity is undoubted, and is generally regarded as late Tertiary. Russell, in his Quaternary History of the Mono Basin[5] (1889) records his opinion that the excavation of many of the valleys of the Sierra Nevada began long previous to the Quaternary, and are, in fact, relics of a drainage system which antedates the existence of the Sierra as a prominent mountain range.

The detrital slopes of the mountains around the ancient lake Bonneville were found by Gilbert to be older than the lake deposits and to extend below the old shore lines and lighter deposits of the lake. He writes:

> The alluvial cones do not find their bases at the level of upper shore lines, but extend downward continuously to the bottom of the valleys, while the shore-lines are wrapped about them.[6]

So, also, Russell found similar conditions at Lake La Hontan. He uses the term 'alluvial slopes."[7]

Turner, following Russell, has recognized the early Pleistocene or Sierran age of a portion of the materials filling the Great Valley of California and of portions of the alluvial fans of the Great Basin.[8]

Red Earth Deposits.—Upon the surface of the flanking slopes of the southwest, the earth is sandy and gravelly, and there is a general absence of vegetable mold or soil containing humus.

The presence of a large amount of red earth in many places is a notable fact, especially as it is more or less argillaceous, stratiform, and interstratified with coarse gravelly layers. It is found in quantity in some of the sections of the general slope, exposed by erosion of surface waters. At the northern end of the Santa Catalinas, red earth constitutes a large part of the upper slope at about 4,000 feet altitude. It is there largely in terrace form and is suggestive of the red-clay formation of the ancient Lake Quiberis in the valley of the San Pedro, evidently an ancient estuary, or landlocked valley; a good evidence of former submergence.

Conclusion.—If it is objected to these views of the origin of the broad slopes under water that we do not find strongly marked sea-cliffs and beach-shingle in connection with the slopes, an explanation may be found in a gradual but continuous uplift, so that all accumulations of shingle were leveled off by the retreating water. And in regard to the shore lines, if any were sculptured, the great antiquity of the formation has permitted their effacement.

The absence, so far as known, of any marine remains is readily accounted for by the earthy and gravelly nature of the detritus, its rapid formation and its constant disturbance by the tides and ocean currents, preventing the local development of marine life.

William P. Blake
University of Arizona

[5] Eighth Annual Report, U. S. Geological Survey, p. 350.

[6] 'Contributions to History of Lake Bonneville,' Second Annual Report, U. S. Geological Survey, p. 184.

[7] Israel Cook Russell, 'Geological History of Lake La Hontan.'

[8] 'Origin of the Yosemite Valley,' *California Acad.*, Vol. I., No. 9, p. 269, 1900.

QUOTATIONS

THE PRESIDENCY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The difficulties of the Massachusetts Institute of Technology in finding a president are deserving of more than local interest. President Eliot remarked in substance to one of the trustees recently, "You offered the place to a Latin professor and he declined, and now I see that you have offered it to a professor of Greek," an observation suggesting that for a school of theoretical and applied science the institute does not object to going considerably afield in its search for a president. The trustees answer, however, that the great college administrator is the great president, and that