GEOLOGICAL SKETCH

By LAMBERT WOOD

Geological Sketch

of the Region of
Tucson, Arizona

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FOREWORD

The following outline of Lambert Wood's war work appears in the history called "Williams College in the World's War," published by the president and trustees of Williams College:

First Lieutenant Lambert Alexander Wood, commanding the Machine Gun Company, 9th Infantry, Second Division, was killed in action southeast of Soissons, in France, July 18, 1918.

He attended the training camp at Plattsburg, N. Y., in the summer of 1916, becoming a sergeant, and in May, 1917, received a reserve commission as Second Lieutenant. At the close of the first O. T. C. at Plattsburg, in August, 1917, he was commissioned First Lieut. U. S. A., and was assigned to the Machine Gun Company, 9th Inf. Regulars, then stationed at Syracuse, N. Y. His regiment went overseas in September, 1917, and, as a part of the Second Division, was brigaded with the French, going up to the front in March, 1918, and participating in the engagements near Chateau-Thierry and the recapture of Vaux, in

June and July, which blocked the German third offensive. On June 6, while his company was advancing, it was subjected to a German barrage, and also, through an error, the American artillery started firing on the same position. After four runners had failed to reach Base Headquarters, Lieutenant Wood volunteered and succeeded in getting through, stopping the fire and saving many lives. When relieved, early in July, Lieutenant Wood had been in the front-line trenches thirty-eight consecutive days. In the Aisne-Marne offensive, during the advance near Soissons, on July 18, he was killed in action while directing his company, which for the two months he had commanded in the absence of the Captain.

He was awarded the Distinguished Service Cross (Posthumously) on June 7, 1919, with the following citation:

"For extraordinary heroism in action at Chateau-Thierry, France, June 6-7, 1918. With entire disregard for personal danger, Lieutenant Wood passed through heavy artillery fire, with a message to stop misdirected supporting artillery fire, which fire imperiled the safety of his organization. He was killed near Soissons, France, on July 18, 1918, while leading his

machine-gun platoon on a flank movement against an enemy group, which was infilading our advancing infantry line."

—*General Orders, No.* 126, *War Department, November* 11, 1919.

He was cited in General Orders No. 40, Headquarters Second Division, July 5, 1918, and in General Orders No. 53, Headquarters Second Division, September 12, 1918, and awarded an engraved Citation Certificate by the Commanding General, American Expeditionary Forces, but both citations and the gallantry certificates were cancelled because of the higher award of the Distinguished Service Cross for the same acts.

On March 12, 1919, Lieutenant Wood was posthumously awarded the Croix de Guerre with Gold Star, under Order No. 14,307 "D" General Headquarters, French Armies of the East, with the following citation:

"A fait preuve d'une grande bravoure dans le commandement de sa compagnie de mitrail leuses, couvrant le flanc gauche tres expose de son Regiment. A ete tue au cours du combat, le 18 Juillet 1918, au Sud-Ouest de Soissons."
("Gave proof of great bravery in the command

of his machine gun company, covering the very exposed left flank of his regiment. Was killed in the course of the combat the 18th day of July, 1918, southwest of Soissons.")

A TRIBUTE TO LIEUTENANT LAMBERT WOOD BY AN ASSOCIATE OFFICER

A GREAT FRIENDSHIP existed between Lieutenant Lambert Wood and myself while in the service. I can say that he was just in his decisions with the enlisted personnel of his command.

He always demanded that the men meet him half way, and in that way he won the undying respect of all the officers and enlisted men in the Battalion. He was always courteous and even-tempered. He was a man who feared nothing; even in his last moments of his life. He wanted to know if his command was safe. He did not hesitate even in going out to places where he would send an enlisted man, and in doing so, he won the everlasting respect from the Battalion personnel, which he carried to his grave.

I frequently wish I could always associate in civil life with men as calm and cool as he was under shell-fire.

Yours very sincerely,
LOUIS H. STRICKLAND,
Sergeant Co. D., 9th Infantry.
Second Division.

WILLIAMS COLLEGE
DEPARTMENT OF GEOLOGY Williamstown, Mass.

December 13, 1918.

MY DEAR MRS. WOOD:

I am sending you today an essay which your son, Lambert, wrote while taking a course in Geology with me.

There have been few students in Williams College for whom I have such a strong, personal feeling as I had for your son. Although he was a student of mine for less than a year, nevertheless, he stood out from among his class mates in some indefinable way. It may have been his manliness, or his kindliness and modesty, or all combined. Whatever it was, it was a trait we all admired.

It is difficult to reconcile the loss of such a manly man with the goodness of God, but I have not the slightest doubt that sometime we will learn that the sacrifice was necessary. There was a mighty task to be performed and he was one who gave his life for its accomplishment.

The letter to you published in "Ephriam Williams: A Soldier," was just like him.

I do not wish to intrude on your sorrow or to make it more acute by sending this essay, and I hope I have not done so. With deep sympathy, I am, Sincerely yours,

—HERDMAN F. CLELAND.

A Geological Sketch of the Region of Tucson, Arizona

By Lambert Wood

The Valley of Tucson in Pima County, Arizona, is an expanded portion of the valley of the Santa Cruz river. At Tucson, the river occupies the western side of the valley at the eastern base of the Tucson Mountains, and flows northward toward the Gila River, but sinks in the sand before reaching it. In dry seasons, it is a small and insignificant stream, but is subject to great floods in the rainy seasons. The City of Tucson is situated on the right bank of the river.

The broad valley of Tucson has the appearance of being surrounded by mountain ranges on all sides. The view to the north and northeast, is bound by the high and rugged range of the Catalina Mountains, and their continuation southward

called the Rincons; on the east and south, by the Whetstones and the Santa Ritas; on the southwest, by the Sierritas, and west by the Tucson Mountains. The Tortillitas Mountains, a group lying east of the Catalinas, form a part of the northern and western boundaries of the valley. The region so enclosed by mountains has a width of from eighteen to thirty miles, a length of forty miles, and an area of about one thousand square miles. The altitude is from twenty-four hundred feet at Tucson, to thirty-five hundred feet at the foot of the slopes of the higher ridges. From this margin, the ground descends toward the Santa Cruz river, and in the middle and lower portions, constitutes what is known as the "Mesa," apparently a flat plain, but in reality, a continuous slope, modified locally by erosion. There is a great variety in the age and composition of the rocky ridges, which, rising to an altitude of five thousand feet above the Mesa, give a wide range of climatic conditions and of vegetation.

The principal streams, in addition to the Santa Cruz, are the Rillito, at the foot of the Catalinas, north of Tucson; the Pantano Wash, rising in the Whetstones, and an underground flow of Davidson's Canyon.

The chief canyons of the south slope of the

Catalinas are the Pima, Pantano, Sabino, and the Agua Caliente.

SANTA CATALINA RANGE

It presents a bold rocky front toward Tucson, and rises to an altitude of 9,225 feet in Mt. Lemmon.

The central nucleus of this range consists of crystalline rocks, chiefly granitic and gneissic.

The formations on the southern side of the Catalinas, toward Tucson, are, for the most part, pre-Cambrian gneiss and mica-schists in tabular form, regularly stratified and with included sericitic schists, all believed to represent some of the oldest rocks known, equivalent to the ancient Huronian, Kewcenawan, and Laurentian formation of Canada.

The pre-Cambrian gneissic rocks are also largely developed on the northeastern flanks of the Catalinas, and are there associated with highly laminated mica-schists, the Arizonian. These schists are characterized by extreme foliation and sharp, angular plication presenting zig-zag lines upon exposed surfaces.

Here, also, we find Paleizoic strata resting unconformably upon crystalline schists of the pre-Cambrian, or upon a broad area of coarse granite as at Oracle or in the Canyada del Oro.

The foundation granites are penetrated by great dikes of diorite, which have changed the blue-grey limestones to crystalline white marble as at Marble Butte. Copper ores are developed along the contact, notably at Apache Springs and Leatherwood's Camp.

DEVONIAN ROCKS

Between the Southern Belle Canyon and Pepper Sauce Gulch a long ridge extending eastward, called Coral Ridge, is made up of quartzite, limestone and shaly limestones, in which there is a bed of corals and shells of the Devonian age. The fossils are of especial interest because of their wonderful preservation in every detail of structure. This is due to the permiation of the rock by silicious waters, which have changed the organized structure from carbonate of lime to silica, and have left the surrounding limestone unchanged. The weathering of the rock has left these fossils standing out in bold relief.

A fine section of the stratafied rock formation is found in Southern Belle Canyon. The strata are uplifted and extend southward at an angle of fifteen degrees. The section consists of regular strata of red sandstone, shale, quartzite, sandstones and limestones, resting upon diorite. At the eastern

end of the section, strata of sandstone and limestone abut upon granite.

The beds are the upper members of the series and are probably Devonian, as indicated by the corals. The most prominent strata are the massive white quartzite, with out-croppings due to faulting. The red shales of the lower series pass into red sandstones of compact and even grain. The underlying diorite penetrates this series of shales and sandstones and is itself underlaid by coarse gray granite, which, near Oracle, is weathered into huge boulders by decomposition.

There are several localities of remarkable conglomerates in the northern and central portions of the Catalinas. The component pebbles are chiefly quartzite; they are all much rounded and show the violent action of currents and waves, indicative of shallow seas and insular conditions in remote geologic times.

RINCON RANGE

The central and higher portions of these mountains consist of gneissic, but toward Benson, these crystalline rocks are flanked by an extensive development of Paleozoic strata, chiefly quartzites, shales and limestones, uplifted and contorted and underlain by coarse granite. Silicified corals abound

and indicate a Devonian horizon above the basal quartzites which are probably Cambian.

THE VALLEY OF THE SAN PEDRO RIVER

The valley east of the Catalina Mountains was once the bed of a lake-like, or estuarine, sheet of water, named Lake Guibaris. The San Pedro river, anciently the Guibaris, in dry seasons, is an insignificant stream, draining a considerable area. It is bordered by mountain ranges, forming a valley 10 to 20 miles wide, and about 150 miles long. This river has cut its way through extensive horizontal beds of unconsolidated light red clays and sediments of great thickness, often terraced by river erosion and extending high up the sides of the bordering mountains. Benson, in the bottom of the valley, has an altitude of 3,576 feet. The lacustrine clays rise from this point on each side to a height of 3,000 feet. It appears that the height of the water was about 4,000 feet above the tide. Wells bored in the valley pass through similar sediments for 500 feet without reaching bed-rock. The extensive strata of deatomite and volcano ash, upward of 100 feet thick, are cut through by the San Pedro river.

This range is on the east and south side of the valley of Tucson, and reaches an altitude of 9,432 feet in old Baldy. It is characterized by a great diversity of rock formation, granitic, volcanic, plutonic, and sedimentary.

The northern portion consists of a broad development of paleozoic strata. Southward, are red shales, limestones and basal quartzites. The quartzites are probably Cambrian. The paleozoic sandstones and limestones resting on a granite foundation, give place to rocks of volcanic origin, chiefly in the form of rhyolitic tuffs, consolidated ashes, agglomerates and porphyries. The formations of volcanic origin appear to constitute the bulk of the main south ridge and to extend to the very summit of the highest peak.

The celebrated large ring meteorite, called the Irwin-Ainsa meteorite, now in the National Museum, was found at the mouth of Box Canyon.

Still farther south, a compact strata of blue limestone containing obscure brachiopod fossils, is found dipping westerly at an angle of 45 degrees.

At the base of the Santa Ritas, is one of the most remarkable beds of large rounded porphyry boulders known. They are of all sizes and colors, and are closely compacted and may be regarded as

evidence of stupendous cataclysmic action. West of Salero. there are remarkable strata of snow-white tufaceous flagstones, so thinly and regularly stratified that slabs, yards in area, and a few inches thick, mav be broken out. They show ripple marks on their surface, and the whole series give evidence of deposition in shallow water.

SANTA RITA TUFAS

The high peak of the Santa Rita, with its enormous flanking ridges of volcanic ejectamenta, is certainly a monumental relic of a great center or region of volcanic activity, from which an immense volume of broken rock, rhyolities and ashes were spread far and wide. This underlies the ancient detrital slope which overlies it.

The evidence is conclusive that the greater part of the vast mass of volcanic ejectamenta was spread under water. We have not only the stratafication of the beds of the Santa Rita, but also the white feldspathic flagstones are covered with ripple marks.

There is no doubt that the enormous deposits around the Santa Ritas are of great antiquity, probably pre-Tertiary, antedating the continent uplift at the close of the Miocene.

These mountains, forming the southern limit of the valley, are largely granitic, with strata of subcarboniferous limestone and shales partly metamorphic and copper bearing. The Twin Buttes copper mine is found here, and other mines at Mineral Hill and at Azurite Camp, all in association with porphyritic dikes and garnetiferous veins, the result of replacement of the limestone.

The Sierritas give place farther north to the Tucson Mountains, composed largely of volcanic tufas and agglomerates. The tufas are regularly stratified and uplifted. They are probably pre-Tertiary or Cretaceous in age, the equivalents in this respect of the stratified tufas of the Santa Ritas on the opposite side of the valley.

The western portion of the Tucson Mountains is made up in part of ancient sediments of paleozoic age—limestones, sandstones and shales. Blue limestone, probably lower carboniferous, much traversed by flint, crops out in Snyder Mountain. There are plutonic rocks in great variety in the form of dikes.

The extensive rhyolitic intrusions north and south and on both sides of the Santa Cruz valley, command attention as marking a long line of disruption and faulting of the crust, accompanied, no

doubt, by crusted movements at different periods, parallel to the axes of the uplift of the paleozoic strata. The more distantly characterized and more fusible volcanic rocks, less viscid than the older rhyolites were, are of a later age, and are present in the form of basaltic lavas, spread out originally in great sheets in igneous outpourings upon the upturned edges of the rhyolites and other rocks.

THE MOUNTAIN SLOPES

The mountain ranges about Tucson and generally in the southwest, are separated by broad valleys commonly regarded as plains, or mesas, but in reality, sloping surfaces stretching outward and downward at a gentle inclination. The topography changes rapidly from precipitious declivities to gently inclined surfaces of gravel and loosely aggregated material, the detrital accumulations washed out from the ridges by streams and floods. These deposits consist of boulders and fragments of rocks broken up and partially rounded, together with gravel and sand, all rudely stratified. These materials are coarser and heavier near the mountains than at some distance away, where they become more water worn and fine, but large boulders and coarse gravels are distributed to great distances, even miles away from their sources, and

form thick deposits evidently of great age. These constitute the greater portion of the surface area, estimated together with the alluvius at not less than nine-tenths of the whole.

The angle of inclination is greater near the ridges, but for the middle and lower parts of the slope from 80 to 100 feet per mile is a common gradient.

These slopes are undoubtedly of different ages as the higher ones are beyond the reach of present streams or floods.

FORMER LACUSTRINE CONDITION

The evidences of emergence and uplift given by the detrital slopes are supported by the phenomena of ancient lakes or estuarine deposits. The deposits show the long-continued existence of a large body of water with its surface on or near the four thousand feet contour line. The uplift of the region and the advent of the Santa Cruz, with the cutting down of its channel, brought these clay deposits to view.

The fact of their being such an enormous volume of detrital materials filling the valleys and composing the slopes, bears testimony to long periods of erosion and degradation of the land, and to eras of greater rainfall than we have now.

CHANGE OF CLIMATE

A change of climatic conditions throughout the southwest and especially in the semi-arid region of Arizona and New Mexico, is marked everywhere by evidence of a much heavier rainfall than we now have. River valleys in many cases show only dry gravelly or sandy beds, which evidently were formerly occupied by continuous streams. Even existing streams in times of great flood do not reach their former carrying capacity or volume, and tell of diminished volume. We may believe that the era of greater precipitation in the southwest and elsewhere was coincident with the widest extension of glaciers, and that while the higher mountains were being loaded with snow, the lower slopes were deluged with rain. The gradual desiccation of Arizona and other regions may be regarded as synchronous with the gradual disappearance of glaciers.

EXTINCTION OF THE GREAT MAMMALS

The fact of the existence and wide geographical range in Arizona of the great mammals, the mammoth and the mastodon, show a very different condition of vegetation up to a comparatively recent geologic time. The extinction of these great Herbi-

vora may be best explained upon the theory of the disiccation, rather than by a change in temperature or increasing cold. A great change in rainfall and the drying up of the slopes and mesas of Arizona, must have caused a great change in the growth of plants, involving their extinction over great areas. It would appear that the extinction of the giant mammals and the disappearance of suitable vegetation for their sustenance proceeded together and were due to increasing heat and dryness rather than to increasing cold.

The coal beds near Deer Creek give ample evidence that in the Cretaceous era, conditions were favorable to forest growth and luxuriant vegetation in the vast swamps that were widespread then.

Quantities of silicified tree trunks near Yuma, and the giant stone trees of the Petrified Forest, bear testimany to such forest growth and to the destructive climatic changes in the Tertiary.

A thick accumulation of spragnum with stumps of trees, and, at the bottom, teeth of the mastodon, are found in Davidson's Canyon.

The former existence in Arizona of a species of Bos of unusual size is shown by the discovery of enormous horn-cores in the gravels of the derivative slopes of the Santa Ritas, at Greaterville.

The comparatively general and uniform altitude of the detrital slopes favors the view that the sea level rested for a long period at about the 4,000-foot contour.

The salient features of the submergence then are—

1. The wide extension northward and eastward of the Gulf of California, northward up the valley of the Colorado River to and into the Grand Canyon and into Nevada; eastward to the upper Gila, and Salt River.

2. The deeply indented and rocky coast line of Arizona with many estuaries and bold headlands.

3. The insular condition of the region of Tucson east and west of the valley of the Santa Cruz, of the San Pedro, and Sulphur Springs Valley forming a veritable archepelago, in which the Santa Catalinas, the Rincons, the Santa Ritas and the Tucson Mountains formed prominent islands.

4. The southern coast ranges of California disappear under water, while the southern end of the Sierra-Nevadas appear as a long narrow promon-

tory disconnected at the Canyada de las Uvas from the Sierra Nadrea, and at San Bernardino from the San Jacinto and the Peninsular Range of Mountains.

Finis