oxygen, but as the volume-flow decreases a point is finally reached at which the demands of the tissues are no longer met.[14] Tissue asphyxia then develops, and with it a process analogous to edema. The walls of the capillaries become permeable;[15] and the serum of the blood and some corpuscles ooze out into the tissues. Three interacting results follow: oligemia, bradyrhea,[16] and asphyxia: *i.e.,* decrease of blood volume, slower and slower flow of blood through the tissues and finally anoxia of the tissues.

Such appears to be the causal sequence through which failure of the tonic activity of the motor centers initiates the development of shock. That this sequence is essentially correct is confirmed by the benefit which is now obtained from the intravenous administration of serum. In shock, if accompanied by little or no hemorrhage, the red corpuscles, which are the oxygen carrying portion of the blood, are still in the body, but stagnant, and need only serum to float them. The benefit afforded by mere serum in shock serves to distinguish shock from hemorrhage; for serum alone, even when reinforced by inhalation of oxygen, as it should be, can transport little oxygen. After an exsanguinating hemorrhage, on the contrary, the essential and only means of saving life is restoration of at least some part of the red corpuscles by infusion of whole blood.

Similar in appearance as are the effects of extreme hemorrhage to those of shock from venopressor failure, hemorrhage[17] has an even closer fundamental likeness to carbon monoxide asphyxia, in which the corpuscles are deprived of their capacity to transport oxygen. Yet in their final stages, hemorrhage and shock are as truly forms of asphyxia as is the tissue anoxia induced by carbon monoxide. In all three conditions, the fundamental need is oxygen;[4,18] but the best method of restoring the supply of oxygen in each is different.

ESTIMATION OF THE VENOUS RETURN

Solution of the problems of circulatory failure has been greatly retarded by the lack of a simple method for estimating the volume of the venous return in health and disease. Under just those conditions of failing vitality in which it is most important to follow the decrease or recovery of the venous return, venous pressure is often immeasurably low. It has, however, been found[19] that significant measurements can be made quite easily when the body is inverted at least to such a degree—a slope of 1:4—that all the blood returning from the tissues is—so to speak—poured into the great veins near the heart: the preventricular reservoir of von Recklinghausen. Although this head-down position is not so much of an aid to the circulation as surgeons generally believe, it is of great value for diagnosis. For when one of the patient's arms is then held vertically, or lifted gradually, the top of the column of blood in the veins usually shows a sharply defined meniscus, and the height of that column above some point of reference, such as the symphysis of the clavicles, affords an index of the volume of the venous return. Estimated in this way that volume has been found to be greatly decreased after some major surgical operations and in cases of acute illness. As recovery develops the venous column rises again; as vitality fails, the column sinks progressively lower until it reaches zero as the tonus of the body's musculature disappears at death.

MILITARY GEOLOGY FROM THE AIR

By Professor JOHN L. RICH
UNIVERSITY OF CINCINNATI

THIS paper is written to call attention to the existence of a small body of men competent to perform a new and unique service in the war effort—the interpretation and mapping of geological information of military value revealed on aerial photographs.

The present war, with theaters of activity in regions little known and poorly mapped or entirely unmapped, many of them in enemy hands and inaccessible for study on the ground in advance of occupation, makes it necessary to depend almost entirely on aerial photographs for both topographic and geologic information concerning areas about to be invaded.

Army engineers have developed methods of interpreting the topography and of preparing topographic maps from the photographs, but they can not be expected to be able to read from the pictures the

[14] Y. Henderson, *Am. Jour. Physiol.,* 25: 395, 1910; 27: 152, 1910; Y. Henderson and S. C. Harvey, same journal, 46: 553, 1918; Y. Henderson and T. B. Barringer, Jr., same journal, 31: 289, 352.

[15] E. M. Landis, *Physiol. Rev.,* 14: 404, 1934; C. K. Drinker and J. M. Yoffey, "Lymphatics, Lymph and Lymphatic Tissue," p. 279. Harvard University Press, 1941.

[16] From βραδύς slow and ῥοία flow. With thanks to my classical colleague, Professor G. L. Hendrickson.

[17] Y. Henderson and H. W. Haggard, *Jour. Am. Med. Asn.,* 78: 697, 1922.

[18] Y. Henderson and H. W. Haggard, "Noxious Gases" (revised edition), Reinhold Publishing Company, 1942.

[19] Y. Henderson and H. W. Haggard, *Jour. Pharmacol.,* 11: 189, 1918.

numerous items of geologic information that may be useful in planning military operations. Among these are the nature of the bedrock—whether hard or soft with all that this implies as to depth of soil, ease of road-building and of all kinds of excavation; whether massive or bedded, and if the latter, whether the beds are horizontal or gently or steeply tilted—features which likewise bear significantly on problems of excavation and ground water supply; whether comparatively undisturbed or badly crushed and broken, and hence difficult to tunnel or mine.

Of equal importance are: features associated with streams such as floodplains liable to inundation, terraces with their well-drained but soft and easily trenched subsoil; deposits of structural materials like sand, gravel or limestone needed for road-building and other construction, which can often be recognized from the air by the trained geologist; and conditions affecting underground water, whether in relation to drinking water supplies or to drainage.

These are only a few of the numerous geological features of military significance which the men of whom I am writing should be able to recognize and interpret from the aerial photographs.

The men competent to perform such services are geologists who combine in their training and experience all the following essentials: (a) Thorough training in geomorphology, the science of land forms, which enables them to recognize by their topographic expression a wide variety of geologic structures and of earth materials. (b) A broad and varied field experience, for it is only through such experience that a geologist gains the high degree of competency necessary for the interpretation of the multiplicity of features likely to be encountered in our present and future theaters of war activity. (c) Experience in actually seeing and interpreting from the air the greatest possible variety of geologic features, and finally, (d) experience in the actual interpretation of aerial photographs and comparison of the appearance of various geological features in the photographs with their appearance on the ground. For this aspect of the geologist's preparation, actual experience in using aerial photographs in the field as base maps for geologic mapping is particularly valuable.

The reason why a geologist with the training and experience outlined above can read so much of the geologic story in aerial photographs, even though they may have been taken in wooded country, is inherent in the fundamentals of the science of earth forms with which the geologist is familiar. He knows what kinds of forms are produced by streams, wind, glaciers or landsliding and how to recognize (within limits) the various kinds of bedrock such as granite, shale, limestone or lava by the distinctive forms into which they are carved by erosion. He is familiar with the differential etching of the earth's surface by weathering and erosion, whereby areas underlain by weak rock are lowered while those underlain by resistant rock stand out in relief, and he is expert in interpreting the structure or "lay" of the rocks by the relief features so produced.

Because the kinds of rock and their structures are thus revealed through the way in which they are affected by the agencies of erosion, the experienced geologist with the training outlined above is able, from photographs alone, to supply a large amount of militarily useful information about an unknown region in advance of its occupation by ground forces. No one but the geologist so trained is in position to do this, because the experience and background training involved can neither of them be acquired in a short space of time. Experience is more or less proportional to the time the geologist has spent in actual field work on the ground and in reconnaissance from the air and study of aerial photographs directed specifically toward the recognition of various types of terrain.

Comparatively few of the geologists of the United States are now competent to do this because comparatively few have had all the required elements of training and experience listed above. Yet those few may be able to render service of inestimable value if stationed at regional staff headquarters. A larger number, lacking perhaps only experience in interpretation of photographs, or in viewing the ground from the air, could however become reasonably competent after a few weeks or months of special training.

The training that most geologists have had, even though through lack of experience they may not be qualified for the work outlined above, tends to make them more than ordinarily competent to carry on the more general types of work in connection with the interpretation of aerial photographs.

Considered broadly, there appear to be four aspects of the interpretation of such photographs: (1) The interpretation of cultural and military features, such as roads, trails, gun emplacements, tracks and trails made by troops, artillery convoys, and so forth. (2) The interpretation of relief. (3) The use of aerial photographs for map construction, and finally (4) the interpretation from the photographs of geologic features as outlined above. Considering each of these aspects in turn:

(1) As to the location of ordinary cultural and military features, men trained in geology probably can not do much more than other reasonably keen and intelligent persons (especially those with some previous military training) will be able to do after a certain amount of practice in the interpretation of

photographs, except that the geologists are much more likely to be able to recognize camouflage as not being in harmony with the natural landscape.

(2) As to relief *per se,* the man with geological training probably will have a decided advantage in recognizing relief features on non-stereoscopic pictures because he will have a comprehension of relief as a systematic topographic expression associated with drainage lines or rock structures, and therefore may be able to infer from drainage lines and vegetation patterns relief features which would not be evident to the untrained observer. Even with stereoscopic pictures the fact that the features automatically fall into logical and therefore easily remembered patterns gives the geologist a distinct advantage.

(3) As to the methods of construction of maps from aerial photographs, geologists in general are not in position to contribute anything not already known and practiced by the Army Engineers. As actual workmen, however, engaged in map-making from the photographs, geologically trained men should have a distinct advantage over others because they are in the habit of using maps and even of making maps of both topographic and geologic features, and consequently should be in position to do effective work much more quickly than men without such training.

As to (4), the interpretation of terrain, that, as I have tried to make clear above, is a field for the few highly trained specialists. It is a field so new that its possibilities are not likely to have been fully realized by army commanders or even by geologists themselves.

In view of the world-wide nature of the present conflict and of the comparatively unknown character of much of the territory over which operations must be conducted, a technique such as the geological interpretation of aerial photographs of areas that can not be examined on the ground promises to yield information of the greatest importance that can not be obtained in any other way.

OBITUARY

C. HART MERRIAM

DR. C. HART MERRIAM, one of the stalwarts of the scientific world, died on March 19 at the age of 86, in Berkeley, Calif. Physician, naturalist, ethnologist, explorer, scholar, lecturer, author, personal friend of Presidents—he was a prominent figure of two generations.

From early boyhood in the Adirondack region of New York, his dominant interests were in the field of natural history. Beginning about 1867 with insects and birds, his activities soon expanded to cover mammals and reptiles, then marine invertebrates and plants. When only 16 (in 1872) he was appointed by Professor Spencer F. Baird, assistant secretary of the Smithsonian Institution, as naturalist of the Government Survey of the Territories (known as the Hayden Survey) and he made extensive collections in Utah, Idaho and Wyoming. In 1875, while a student at Yale, he was summer assistant on the U. S. Fish Commission at Woods Hole, Mass. Following graduation from the College of Physicians and Surgeons, Columbia University, in 1879, he practiced medicine and surgery in northern New York. In 1883, as surgeon of the *SS Proteus* he visited the Newfoundland seal fisheries on the ice floes between Labrador and Greenland.

In 1891 President Harrison appointed Dr. Merriam as Fur Seal Commissioner to represent the United States on a joint American and British commission to study the problems of pelagic sealing on the Pribilof Islands. In 1899 he again visited Alaska and the Bering Sea, on the Harriman Alaska Expedition, whose scientific personnel he selected.

While studying in the museums of England, Holland and Germany, in 1885, he was recalled to organize a division of ornithology in the Department of Agriculture, and soon converted it into the U. S. Biological Survey, of which he was chief for twenty-five years. During this epochal period of investigation, in which he played so important a part, he made field studies or led biological explorations (mainly by pack-horse outfits and most frequently accompanied by Vernon Bailey, long chief naturalist of the Biological Survey) in every state and also in Bermuda, Canada and Alaska. Among the more important of these surveys in the Far West were those of San Francisco Mountain, Arizona, including the Painted Desert and a section of the Grand Canyon; the Death Valley region and neighboring deserts in California, Nevada and Utah; the Snake Plains and adjacent mountains in Idaho, and Mount Shasta in northern California.

In addition to their many other scientific values, these and other explorations were proving grounds for Dr. Merriam's development of the laws of temperature control of the geographic distribution of animals and plants in North America. His life-zone concepts have been widely accepted by the scientific world.

He was a member of the U. S. Board on Geographical Names for twenty years and chairman for eight years. Two natural landmarks bear his name: Mount Merriam in California, amongst the group of High Sierra peaks that have been named for eminent scien-