THE OUTLOOK FOR GEOLOGY AND GEOGRAPHY

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1. Experiences of the War

Before speaking of the outlook in geology and geography it will be worth while to consider briefly some applications of these sciences to war activities in the several armies.

The usefulness of geology and geography in the war is not generally realized. Indeed their possible use, either directly or indirectly, seemed unlikely to those in responsible charge of the American program, until the scientists themselves had by persistence shown that these earth sciences have many practical applications to warfare, and to those home industries necessary to sustain the army and the nation. However, the government accepted these professional services gradually; rapidly in some lines and slowly in others. The strenuous efforts made by groups and by individuals to bring this about would make a most interesting and entertaining story if it could be fully written. It is enough to say of the efforts, that they succeeded to a marked degree before active fighting stopped, and that geologists and geographers were giving increasing service with the following agencies: the field army, the military intelligence, the officer training camps, the war industries, war trade, and shipping boards, the fuel administration, and the House commission engaged in preparing for the peace conferences. The work of these men made a splendid impression, and a brief statement covering some of it will be enlightening.

Of first importance was the making of accurate topographic maps of large scale for control of artillery fire. About one hundred commissioned topographers from the U. S. Geological Survey were engaged in the work on the American lines, and in cooperation with the French. A map-printing plant, larger than the combined plants in

Washington and capable of producing nearly 1,000,000 maps each month was erected and operated. Many of the maps were revised and reissued daily. As a result, all officers now realize as never before the dependence of an army on topographic maps.

Related to map-making was the building of relief models. These were used in studying the visibility of the country from observation posts; and assisted in controlling shell-fire on enemy targets. Finished models showing relief and villages and roads were made by the thousands, and in the remarkable time of a few hours for each original mold, after which any number of fac similes could be made quickly.

Another vital need of the army was an enormous supply of water for men and horses, for concrete construction work, and for power plants and locomotives. Geologists made maps showing locations of springs and of shallow and deep water-bearing rocks. They also supervised the boring of wells, especially in the British army.

Supplies of rock, gravel, and sand were also needed in large amounts for building roads, gun foundations, dugouts, supply depots, and harbor works. Geologists assisted in locating the material.

Finally, maps and diagrams were made of the rock formations along the lines held by our army, and by the enemy, in order to show their suitability for the construction of trenches, dugouts, and mines. It was possible to observe existing works, and then to predict the conditions in new areas which were geologically similar. Thus, it was possible to say in advance whether trenches would stand without revetment of the walls; whether they would be wet or dry during certain seasons; and to advise regarding tools which would be needed to construct defensive works. Maps were prepared to show the probable effect of artillery fire on the formations; thus, whether the rocks would shatter and add to the casualties; and whether barrage fire would make the ground impassable for tanks.

These various uses for geologists in direct warfare were developed by the allied armies in varying degrees, but the Germans had prepared a systematic organization in advance, or at an early date. Our geologists and geographers

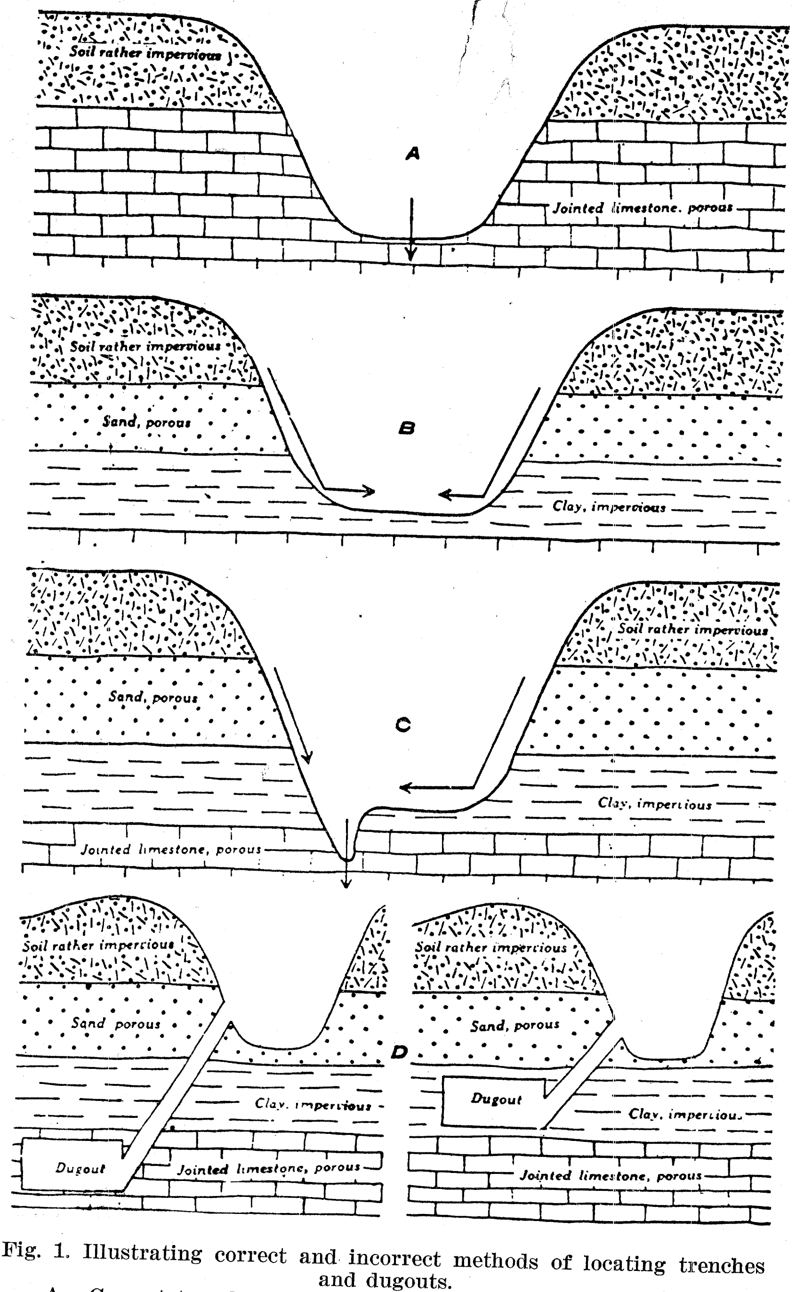

Fig. 1. Illustrating correct and incorrect methods of locating trenches and dugouts.

A. Correct trench construction. Water escapes through the porous jointed limestone.

B. Incorrect trench construction. Water is held in trench by impervious clays.

C. Correct trench construction under same conditions as "B", when it it is not feasible to sink the whole trench to the level of the porous limestone as in "A".' A small drainage trench carries water down into the porous limestone, permitting its escape.

D. To the left, properly placed dugout. Drainage takes place readily through the limestone, making the dugout relatively dry. To the right, improperly placed dugout. Water fails to escape through the impervious clay and the dugout is subject to very poor drainage or even flooding.

at home tried unsuccessfully in 1917 to have techincal units organized for service at the front, and to introduce certain kinds of instruction in the officers' training camps. In 1918 these hopes were partly realized when a number of geologists and geographers were commissioned in the war college intelligence office, and the geological service with General Pershing began to expand. Later, the educational committee in charge of the S. A. T. C. courses planned to require certain courses in map reading, map-making, and military geology. For this purpose the Geology and Geography Division of the National Research Council prepared three textbooks covering military geology, meteorology, and the geography of western Europe.

Aside from these military efforts, the most active service of American geologists during the war was in the development of domestic mineral supplies for essential industries. The average citizen was aware of the threatened shortage of coal and of oil, but did not realize that we were dependent on foreign imports for manganese, chromium, and molybdenum for steel tempering; of pyrite and platinum for making acids for explosives; of graphite and clay for metallurgical crucibles and retorts; of antimony for hardening lead bullets; of potash for fertilizers; of optical glass for instruments; and of numerous other minerals for essential purposes.

Geologists pointed out that the development of domestic supplies of many of these minerals would lessen the danger of submarine attacks on vital commerce, and would permit the use of more ships for transfer of soldiers and munitions to Europe. The search for domestic supplies and the encouragement of production and use, was undertaken by the U. S. Geological Survey, the Bureau of Mines, the state geological surveys, and by mining engineers and metallurgists. The results of the work were so successful that many large ships were transferred to direct war service, and many of the industries formerly dependent on imported minerals were largely or wholly supplied from home sources. Furthermore, to relieve railroad burdens, many ordinary domestic minerals were located and developed in new places close to market.

Work of the kind just described was undertaken in Illinois by the State Geological Survey in cooperation with other state and federal agencies. Fluorite for optical use was discovered, and sand for optical glass was investigated. The Survey demonstrated the practicability of recovering pyrite cheaply from our coal mines and made an estimate of possible output. Promising deposits of fire clay and ganister for making refractory linings were examined and tested. The efforts of former years to locate new oil fields were continued, new work was undertaken to prolong the producing life of our old fields by demonstrating methods of protecting oil sands from encroaching water. Other work of permanent as well as war-time value was the development of methods for using Illinois coal instead of transporting eastern coal and coke for the manufacture of city gas. These various special activities largely supplanted the usual work of the Geological Survey.

2. The Future Prospect

Having now reviewed the work of geologists and geographers during the war period, can we foresee any further development or any change in the application of these sciences for the immediate future? As a colleague has said: "For two years we have been sharpening the sword and applying every effort to perfect its cutting edge", now we are to return to the field, the laboratory, and the classroom.

What lessons have been learned regarding the practical value of the earth sciences to the world, the nation, the state, and the individual? What improvements are possible in research? What of the larger social and political value of a knowledge of natural processes, world-geography and of world resources?

In answer, we have gained an added conviction of the fundamental value of topographic maps for defensive and offensive warfare; in the selection of routes for highways, railroads, electric power and communication lines; in the development of drainage and of water supplies; in the search for, and development of, minerals and other natural resources. The topographic map of the United States should be completed, not in 80 or 90 years, according to the former rate of progress, but in twelve or fifteen years. The map of Illinois should not proceed at the old rate, which promised completion in 1960, but should be finished by 1930. The cost will be more than saved to the taxpayers by eliminating surveys for roads, water supplies, and other necessary developments throughout the entire State.

Similarly, geology has again demonstrated its practical value in locating water for domestic and industrial uses, and stone, gravel, and sand, for building of roads, railroads, and other structures. A state like Illinois, about to invest $60,000,000 in the beginning of a hard-road system, should first locate and investigate the materials which are available close to the selected routes. Furthermore, a state about to build a great waterway, should know the location and usefulness of the heavy, slow-moving mineral wealth in the adjacent territory which will help furnish profitable cargoes.

Again, we have seen in connection with minerals for war industries, the value of statistics of mineral production, of lists of producers, and of geological investigation of possible new sources of supply, in advance of acute need. Thus, in Illinois, we owe it to the nation, as well as ourselves, to collect accurate statistics, to complete an inventory of our enormous mineral wealth, and to encourage new or improved methods for its production, conservation, and wise utilization.

But while some of us, who needed no demonstration, have seen the justification of practical geography and geology, we have been dismayed to find, even in high places, that there was little, if any, advance appreciation of the military, industrial, and social significance of these sciences. They had been considered purely cultural and academic! No conception of their importance existed in the academies at West Point or Annapolis, in the intelligence service, or in the early organization of the boards for war industries, war trade, and fuel control. Representatives of the professions were repeatedly refused the chance to serve the country with their special talents, and finally gained the opportunity only by personal persistence, and in many cases without recognition of their profession. One cannot blame others for this condition, and I do not wish to criticize those who were doubtless following to the best of their ability the lines indicated by past education and experience. It is our fault that these subjects have almost disappeared from the high schools, and have never been so perfected as to be appreciated by engineers and by the general public.

Evidently the future problems of geology and geography include not only the better organization and pursuit of research, but the better dissemination of knowledge of the usefulness and significance of these sciences to every-day affairs. Our common schools and high schools should teach some of their required courses in terms of earth science. Our colleges and universities must develop *special* courses in geology and geography which will be recognized as essential to professional courses in civil, mining, chemical, and ceramic engineering, and to those in economics, sociology, and history. Many engineering schools now give such instruction without requiring geology. In the future it will not be sufficient to teach only general courses and others adapted to students who are specializing in the earth sciences.

Similarly, in the routine work of official surveys and bureaus, an effort must be made to meet more of the needs of the mineral industries by cooperation with them, and by making known the results of investigations in common language rather than in the stereoptyped form and professional lingo to which we have been accustomed. The maps presented should display more effectively and in more detail the character, usefulness, and distribution of the rock formations, while continuing to show also as formerly their relative ages and modes of origin. There should be more effective consultation and cooperation between state surveys and between state and federal surveys regarding development of purposes and methods, in order that official geology may be more practical than in the past, and also in order that fundamental problems of origin and correlation of the various formations and their enclosed minerals may be attacked on a national scale more vigorously than heretofore. Just as the experience of the war indicated the impracticability of centralizing all knowledge and all administrative power in Washington, and the consequent need for state councils, directors, and administrators, so strong, official surveys and bureaus are required in both the national and the state governments, and their work should be better correlated and more cooperative than in the past.

In regard to pure research in the earth sciences, it seems probable that much talent and time has been wasted in the universities and other research institutions by lack of cooperation on a national and international scale. There has been too little knowledge of progress elsewhere, and of the relative value and timeliness of alternative problems to be undertaken. A most promising sign for the future lies in the proposed development of the National Research Council in this country, and of similar councils in many foreign countries. These councils will surely stimulate and systematize all scientific research, without improperly checking individual initiative and originality.

Following development along the lines which I have indicated, I trust the earth sciences will influence the United States and the whole world to a marked degree in the coming period. As a result of our participation in a foreign war for democratic ideals, and as a result of the world trade in which we shall engage, we must have a knowledge of foreign lands, their physical character, their resources, and their peoples, together with a better knowledge of our home country. A knowledge of human geography is to become of great importance to our whole population. Furthermore, for the solution of problems leading to social and political unrest, and for the universal establishment of justice, the world needs to *know* and to *rely* on the orderly and inevitable processes of nature, which are nowhere better exemplified than in the study of the earth sciences.