Thiobacillus thiooxidans in as high concentration as 20 per cent in the form of magnesium sulfate."

The temperature of the acid waters issuing from the abandoned areas tends to be below 20°C. Vogler, LePage, and Umbreit (*9*) found that sulfur oxidation proceeded over a temperature range of 7° to 45°C.

Thiessen (*7*) reported that sulfur in all coals is "present in amounts ranging from traces to as high as 10 or more percent, commercial coals of the Eastern United States contains from 0.5 to 1.5 percent of sulfur." Thiessen stated that sulfur does not occur as such in coal but is present in organic combination as part of the coal substance and in inorganic combination as pyrite or marcasite and, especially in weathered coals, as calcium sulfate. Mellor's (*5*) compilation is a rich source of information dealing with the iron disulfides, pyrite and marcasite. Two of the many items of interest concerning these inorganic combinations of iron and sulfur are the statements concerning the weathering or the ready breakdown of marcasite under the influence of moist conditions and the finding of free sulfur in the naturally-occurring iron disulfides.

Kirner (*4*) reports that bituminous coal has a nitrogen composition ranging from 0.6 to 2.8 per cent. The complete story of the forms in which this nitrogen may appear in the coals and, indeed, whether such compounds are available to microorganisms is not known. Starkey (*6*) found that with *Th. thiooxidans* there is some oxidation in media receiving no nitrogen other than that which may have been absorbed from the air or introduced as impurity in the non-nitrogenous compounds incorporated in the medium. Of the nitrogen sources investigated, ammonium nitrogen is the only one that has been found to be available to the organism.

In this work, a bacterium, unidentified as yet, has been found in acid mine drainage which is involved in the oxidation of ferrous to ferric sulfate. A second bacterium similar, if not identical, in its morphological, cultural, and physiological characters to *Th. thiooxidans* has been isolated repeatedly from the acid mine drainage of some bituminous coal mines. It is postulated that this latter or an unknown similar organism is involved in the oxidation of the sulfur and the sulfur compounds to sulfuric acid. The increasing demands for abatement of stream polution by acid mine drainage has intensified the efforts of many agencies to solve the problem. It is felt that the mine-sealing program has not given a complete solution and it is suggested that the study of the relation of certain microorganisms to the formation of the sulfuric acid in the mine might be a most profitable one.

References

1. Carpenter, L. V., and Herndon, L. K *W. Va. Univ. eng. exp. Sta. Bull. No. 10*, 1933.
2. Hodge, W. W. *W. Va. Univ. eng. exp. Sta. Bull. No. 18*, 1938.
3. Hoffert, J. R. *Ind. eng. Chem.* (Ind. ed.), 1947, **39**, 642.
4. Kirner, W. R. The occurrence of nitrogen in coal. In *Chemistry of coal utilization.* (Vol. 1.) New York: John Wiley, 1945.
5. Mellor, J. W. *A comprehensive treatise on inorganic and theoretical chemistry.* (Vol. 14.) New York: Longmans, Green, 1935.
6. Starkey, R. L. *J. Bact.*, 1925, **10**, 135, 165.
7. Thiessen, G. Forms of sulfur in coal. In *Chemistry of coal utilization.* (Vol. 1.) New York: John Wiley, 1945.
8. Vogler, K. G. *J. gen. Physiol.*, 1942, **26**, 103.
9. Vogler, K. G., LePage, G. A., and Umbreit, W. W. *J. gen. Physiol.*, 1942, **26**, 89.
10. Vogler, K. G., and Umbreit, W. W. *Soil Sci.*, 1941, **51**, 331.
11. Waksman, S. A. *J. Bact.*, 1922, **7**, 605.
12. Waksman, S. A., and Starkey, R. L. *J. gen. Physiol.*, 1922, **5**, 285.

Reconnaissance Soil Survey Work in Japan

C. L. W. Swanson[1]

Department of Soils, Connecticut Agricultural Experiment Station, New Haven, Connecticut

THE RECONNAISSANCE SOIL SURVEY OF Japan now being conducted by American scientists is the first of its kind to be made of that country using modern survey methods for classifying and mapping soils in terms of their morphological features. Soil maps of Japan now available from Japanese sources have been made according to the old geological method of soil surveying similar to that used initially in the United States.

During the past 20 years Japan has produced only 80–85 per cent of her annual food requirements. Because of the food shortage there and in the world as a whole, the maintenance or increase of food production has now assumed particular importance. Since modern soil maps which could be used as an aid in maximizing Japan's food production were unavailable, the survey was undertaken.

The most important agricultural areas are being mapped first, particularly the larger plains and more nearly level regions. The hilly and mountainous sections are of little importance agriculturally. A preliminary field survey was made of Japan before any reconnaissance surveys were initiated. Reconnaissance soil surveys of the Kanto Plain area near Tokyo and the island of Kyushu have been completed (Table 1). Surveys in progress include the islands of Hokkaido and Shikoku, and the Osaka Plain on the main island of Honshu. A soil map (1:250,000) printed in color and a report similar in outline to that of the Soil Survey Division, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. De-

[1] Formerly Major, Air Corps, and head of the Soils and Fertilizer Branch, Agriculture Division, Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers, Tokyo, Japan.

partment of Agriculture, is to be published for each area surveyed. Because of the nature of the survey, only associations of soils are shown on the soil maps.

Several sources of data and information are used in preparing the map and report. Much of the information is obtained through field observation of the soils by experienced American soil surveyors and from Japanese soil and geological maps. Map information and soil data already gathered by Japanese scientists are being coordinated and interpreted in terms of modern soil concepts and nomenclature. Arrangements have been made with the Soils Departments of the Imperial Universities of Japan to make physical and chemical determinations on soil samples taken in the field during the course of the survey. Samples are also being sent to the Soil Survey Division, U. S. Department of Agriculture, for analysis.

TABLE 1

Soil group	Kanto Plain*		Kyushu†	
	Acres	Per cent of total area	Acres	Per cent of total area
Brown forest	2,241,551	28.14	777,431	8.51
Alluvial	1,605,317	20.16	981,531	10.75
Black forest	100,332	1.26	115,275	1.26
Half bog	75,647	0.95	0	0
Planosols	35,036	0.44	224,599	2.46
Red and yellow podzolic	0	0	193,689	2.12
Lithosols	691,975	8.69	1,829,257	20.04
Sands	73,258	0.92	34,621	0.38
Rough mountainous land	2,981,302	37.44	4,941,461	54.11
Barren volcanic rock	0	0	33,909	0.37
Water	159,258	2.00	0	0
Total	7,963,676	100.00	9,131,773	100.00

*About 33 per cent of the area is now being used for agricultural purposes.
†About 20 per cent of the area is now being used for agricultural purposes.

For many years Japanese soil scientists believed that the soils of the country did not fit into the prevailing scientific scheme of classification and, therefore, would not accept the modern concept of great climatic soil groups. While placing their greatest emphasis on geological effects on the formation of soils, they did admit that vegetation and climate exerted certain influences on soil formation processes. It is not surprising, however, that the Japanese did not readily accept modern soil survey methods, for even in the United States there existed certain areas where initially it was difficult to apply the modern pattern. As late as 1935, Marbut, in his *Soils of the United States* (see C. B. Hutchison's *California agriculture*. Berkeley: Univ. California Press, 1946), was unable to delineate in California representatives of the great soil groups of the world.

In 1937, however, an Outline Soil Map of Japan (1:5,000,000), prepared by Toyotaro Seki, of the Imperial Agricultural Experiment Station in Nishigahara, Tokyo Prefecture, was published in an article by L. G. Scheidl (*Mitteil. dtsch. Ges. Natur Volk.* Ost., Vol. 30, Pt. A). This map includes and recognizes the role of climate and vegetation in soil development, establishing the morphology of the soils themselves as the basis of classification. Detailed soil surveys of parts of Aomori and Gifu Prefectures were made by the Japanese using this classification scheme, the soil survey program having been curtailed during World War II. The Japanese are now being encouraged to activate their soil survey work as rapidly as possible. Whenever practicable, technical assistance in the reactivation of their soil survey program is being given by American soil scientists. In this connection, the published reconnaissance soil survey reports and maps of Japan will be made available to them.

Certain representatives of the major zonal and intrazonal soil groups of the world are now being identified in Japan (Table 1 and Fig. 1). It is being observed that profile characteristics are similar to those in the United

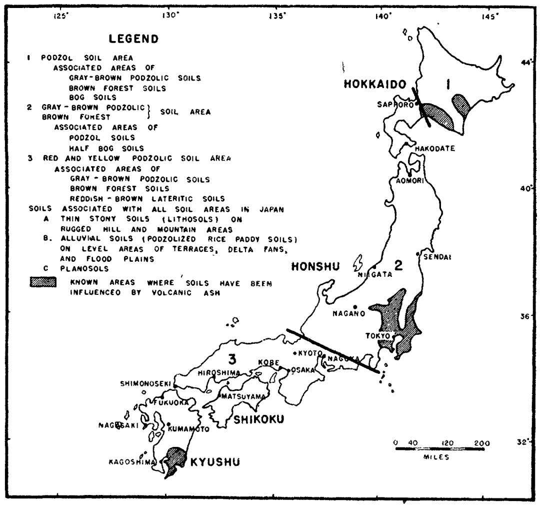

FIG. 1. Generalized soil map of Japan.

States at comparable latitudes; it appears, however, that local topography and parent material, especially volcanic ash materials, exert more influence on the kinds of soils developed than does climate. When one considers the extremely rugged terrain and steep slopes that prevail over most of Japan, it is understandable why the Japanese, until recently, gave little consideration to climate and vegetation influences as important soil-forming factors. The many diastrophic movements that have occurred quite recently, geologically speaking, have naturally tended to maintain or increase the areas of rugged terrain and steep slopes, thereby continuing conditions conducive to the development of immature and young soils. The high rainfall generally prevalent in Japan helps to hinder the development of soil profiles by eroding weathered materials from the slopes. The constant changing of the topography, the continual removal of weathered materials to lower levels, the additions of volcanic ash, and the high rainfall have all combined to assure that materials in a given locality would not be given time to develop mature profile characteristics.

The most important soils of Japan, which support the bulk of the population, are the alluvial soils developed in the lowlands. On these, paddy or irrigated rice is grown during the summer, and in southern Japan (Fig. 2) during

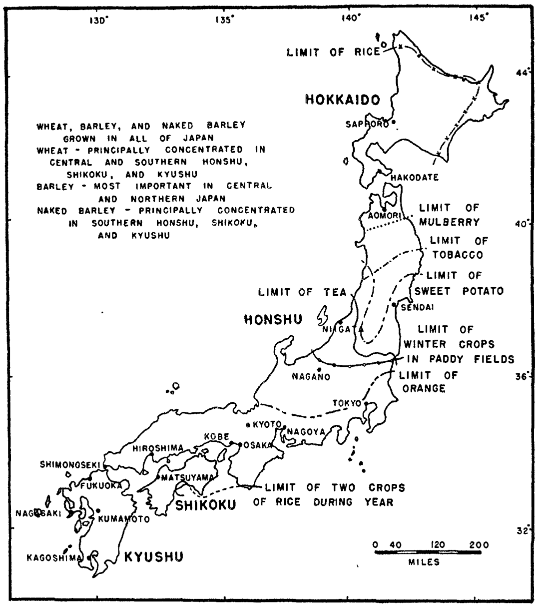

FIG. 2. Northern limits of a number of crops in Japan.

the winter months these soils are also cropped to wheat or barley. Many of the important agricultural soils are developed on volcanic ash (Fig. 1). Brown forest and black forest soils,[2] derived principally from volcanic ash materials, are important upland soils used for crop production purposes. Since these are especially low in available phosphorus, they are comparatively low in inherent fertility. They are physically well suited to growing small grains, white and sweet potatoes, vegetables, mulberry, upland rice, tree fruits, tea, tobacco, and other non-irrigated crops.

In many of the red and yellow podzolic soil areas (Fig. 1), because the demand for cropland is so great, a large number of the steep slopes poorly suited to agriculture are terraced and cropped. The crops grown are wheat, barley, upland rice, white and sweet potatoes, vegetables, and, in many places on southern slopes facing the sea, citrus fruits are grown. Podzol soils occur at the higher elevations in Hokkaido and northern Honshu, but they are more widespread in the former area than in the latter. In these areas they are associated with coniferous vegetation. Most of the gray-brown podzolic soils, which are developed in the hill and mountain areas of the podzols (Fig. 1), are forested, but where the soil is deep enough, farmers have either terraced them or planted the row crops up and down hill without the benefit of terraces. In the unterraced fields, soil erosion is quite severe. White potatoes, tree fruits, vegetables, small grains (wheat, barley, oats), corn, and hay are the upland crops grown on these soils. Lithosols, which are found on the perimeter of the undulating and rolling plains adjacent to mountains and in upland areas in mountainous regions, are not well suited to crop production and are mostly in forest vegetation.

For maximum crop yields, most of the soils of Japan require heavy fertilization and liming. Fertilizers are of real importance because of the intensive agriculture and because the scarcity of agricultural land makes it important to secure high yields from every crop grown. The preponderance of hilly and mountainous terrain sets definite limits to the cultivated area and explains why no more than 15,000,000 acres, or 16 per cent of the total area of Japan, is cultivated.

Locally produced materials, such as compost, night soil (human excrement), green manure, and wood and straw ashes are used extensively as fertilizer materials. Bean cake and fish fertilizers have been applied to the soil in the past, but recently these materials have been used largely for food purposes. Large quantities of commercial fertilizers, particularly ammonium sulfate and superphosphate, have been employed. Their use was curtailed during World War II because production of nitrogenous fertilizer was retarded, while production of phosphatic fertilizer was dependent on imports of phosphate rock. When world consumption (1935–37) of commercial fertilizers used by each country is considered, Japan ranked third for nitrogenous fertilizers and sixth for phosphatic and potassic fertilizers (K. G. Clark and M. S. Sherman. *Prewar world production and consumption of plant foods in fertilizers*. U. S. Dept. Agric. Misc. Publ. 593, 1946). Yet that country ranked nineteenth in the world distribution of arable lands.

[2] The names "brown forest" and "black forest" were originally given to the soil groups so designated by Japanese and German soil scientists and some question exists as to the correctness of this application. The brown forest soils do not have all of the profile characteristics normally associated with brown forest soils, being acidic in nature and slightly podzolized. Consideration is now being given to assigning a new great soil group name to these soils.