

THE MEANING OF SOIL TYPE

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During the past 30 years the soils of this country have been the subject of a sustained scientific exploration, which has resulted in an expansion of our knowledge and understanding of them that was almost undreamed of a generation ago. This has, in the main, been the work of the New Zealand Soil Bureau of the Department of Scientific and Industrial Research; though the early stages were directed by the Cawthron Institute, under the leadership of Sir Theodore Rigg.

The Soil Bureau had its beginnings in a Soil Reconnaissance Division of the Geological Survey created in 1930 to meet an urgent practical need; namely, to discover the cause of the serious stock unthriftiness (bushsickness) then being experienced over wide areas of recently settled pumice-lands in the middle of the North Island. In turn its attention and growing experience were directed to a succession of specific land problems; the soil survey of the irrigation areas of the South Island; the problem soils of the North Auckland peninsula, then being rapidly opened up for closer settlement; the problem soils (Pakihis) of the West Coast, where farming potential was at last becoming more important than timber and mining as a source of wealth; and the serious menace of soil erosion in both Islands. These and many other similar challenges, successfully met with the aid of the new and improving methods of soil survey, proved the recruiting and training ground for the growing team of pedologists, soil chemists, soil physicists, soil biologists, cartographers, and others, who now comprise the New Zealand Soil Bureau.

During these formative years it gradually became possible to envisage and plan a systematic soil survey of

the whole country, as an essential stock-taking of New Zealand's most productive asset—the land. Much progress toward that end has now been made; the soils of some sixty districts, large and small, throughout the country have been surveyed in greater or less detail; and published reports and maps of the more important of these are now appearing regularly as Soil Bureau Bulletins. In addition, reconnaissance soil surveys at 4 miles/inch have been completed for the whole country; and a genetic classification of our soils into major Soil Groups and sub-Groups (see below) has been produced, which has already proved an invaluable aid to research in soil problems. When the final revision of the South Island 4-mile sheets has been completed and they have been published, New Zealand, it has been said, "will have an evaluation of its soil resources **unparalleled in any other country.**"

The Use of the Soil Maps

The value of these soil maps lies not only in the fact that they provide an inventory of soil resources; but, even more important, in the fact that they make possible the gradual accumulation of a body of useful knowledge about each of the recognised distinct kinds of soil. This was not possible before that classification and distinction was made. Thus, soils suited to or unsuited to various crops, soils that need lime, soils that respond or do not respond to the various possible combinations of the different fertilisers and trace elements—these become known for their needs and their potentialities, and by their names and locations, once the task of sorting them out, defining them and giving them names has been accomplished. In this way land use can become more scien-

tific—which is only another way of saying that a lot of the guesswork is removed; and it is not surprising that advisory officers now base their recommendations, either individually to farmers or generally in articles in the "Journal of Agriculture", on their own accumulating knowledge of the soil units presented in the soil maps.

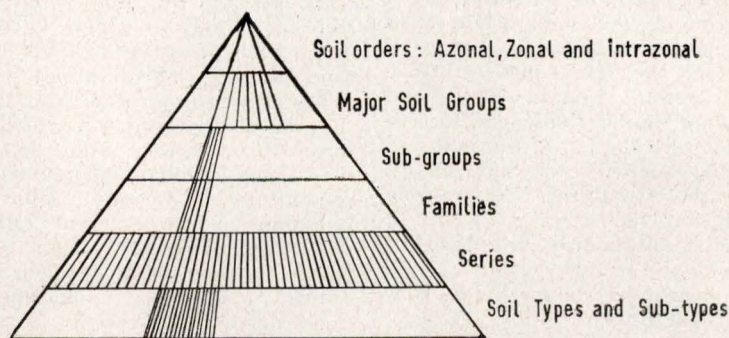
The term soil type, therefore, is being rapidly assimilated into our farming language, just as other technical terms like gammexane, molybdenum and selenium become commonplace in a matter of a few years. But since the term soil type appears to have an obvious or general meaning, as merely a type or a kind of soil, the term is frequently used incorrectly. Farmers are becoming familiar with the names and characteristics of the soil types of their own farms and districts, so it is becoming important that the meaning of soil type should be more widely and clearly understood. A soil type is, in fact, a very precise concept, and only one of the hierarchy of soil units, ranging from the smallest units, the sub-types and phases, to the soil types themselves, and up through the series, families, sub-groups and major soil groups into which the country's vast array of natural soil differences has been classified. This pyramid of soil classification resembles the organisation of an army into platoons, companies, battalions, etc., in which each higher unit is made up of several units belonging to the tier just below it. (See Fig. 1.)

Scales of Mapping

The soil types are the basic units of soil classification and mapping; but

whether or not they will be found in a particular soil map depends on its scale. If small scale maps are consulted, such as the Soil Map of New Zealand (32 miles/inch) or the 4 mile/inch sheets already mentioned, the individual soil types will not be found, because any attempt to represent them at that scale would result in a too closely drawn mass of confusing detail. A map, after all, is not intended for use under a powerful magnifying glass. The Soil Map of New Zealand can only show, and is only intended to show, the higher categories of the classification, such as the Yellow Grey Earths of the dry eastern downlands, or the moderately weathered, strongly leached, Yellow Brown Earths of the wet forested (or once forested) hills of Southland. These are NOT soil types, but soil groups and sub-groups (Fig. 1); and they express over large tracts of country a general similarity of soils which results from the dominant influences of climate and vegetation, and other incisive soil-forming factors. (Readers are referred to Bulletin 302 of this series, "The Scientific Basis of Soil Mapping" for a fuller account of these factors, and their expression in the soil profile.)

Even on the 4-mile maps of which each sheet covers a smaller portion of the country, the smallest units that can be shown (each represented by its own colour and symbol or number), are groupings of closely similar and related soil types. In compiling them, many soil differences, as of texture and depth, that are of local agricultural importance, have had to be ignored and boundaries smoothed for the sake



The Pyramid of Soil Classification

Fig. 1.

of clarity. Such maps are of distinct value in portraying the broad pattern of soil differences and relationships over large areas, so long as their inability to reveal the actual soil type at a particular spot is kept in mind. As will be seen, no map can show all the detail of nature's infinite variety, no matter how large its scale.

In practice it has been found in New Zealand soil mapping that when the scale reaches 2 miles/inch then many but not all of the individual soil types can be shown; and that when the scale is as large as 40 chains/inch (as in the detailed maps being issued for certain countries) then all the soil types and sub-types are capable of clear presentation.

It is important that the users of soil maps should appreciate their limitations. Even when mapping on a large scale of, say, 20 chains/inch, an area of one soil type will often be found by the soil surveyor to include small pockets or narrow bands of a different soil (perhaps a shallower more stony soil than the type admits) which nevertheless cannot be drawn into the map, solely for the reason that there must be a limit to the fineness of detail shown. It follows that the occurrence on a published soil map of a uniform patch of colour, with its appropriate symbol or number, is not a guarantee that the soil within that area is as uniform as the clear patch of colour suggests. It merely states that on the whole the soil within that area is of that type; but it cannot tell you whether it is continuously so (as is often the case) or whether it includes small pockets of different soil that could not be mapped at that scale. Sometimes it is obvious to anyone on the spot that such is the case; sometimes only an inspection by an expert can decide.

The possibility of making incorrect deductions from the map is perhaps greatest in the case of the reconnaissance soil maps drawn to the scale of 2 miles/inch, on which many of the soil types are shown. An example is the Soil Map of the Downs and Plains of Canterbury and North Otago. At this scale, the need for clarity of mapping has made it necessary to omit isolated areas of any soil type that are smaller than 100-150 acres, and to effect

some smoothing and simplification of boundaries during the final drawing of the map. This, after all, is the sort of thing that has to be done in the drawing of all maps, of whatever kind of purpose. It means, in this case, that in many districts one simply cannot make an assured deduction from the 2-mile map as to the soil type or types to be found in a particular field. When this information is required, reference must be made either to a more detailed map (when such exists) or to an expert who is familiar with the profiles of the local soil types.

The Soil Type

What has been said on the problem of trying to represent nature's infinite variety on a sheet of paper is important for the proper understanding of the meaning of soil type. As explained in Bulletin 302, soils are studied, compared, classified and mapped in terms of their profiles—the profile being the sum-total of characteristics presented when the whole depth of the soil, top soil and subsoil down to 2-3 feet or more, is examined. But a particular profile represents the soil at one spot only, and there is always a natural variation from spot to spot. It is almost impossible to find a square chain of land anywhere in which there is not some variation.

Consider, then, the problem confronting the pedologist (soil surveyor) when he commences the soil survey of a new area. In the first place, the soil types are not already lying there as separate and distinct natural objects waiting to be recognised, like the many highly individual plant species that can be counted in a forest. They are at the commencement no more than ideas in the pedologist's mind, convenient sub-divisions of the soil's natural variability into arbitrary and useful units. These units, the sub-types, types and series, have to be created or established before the survey can proceed. Now, in establishing his types, if he were to decree that each soil type must have one precise kind of profile, with no variation permitted, he would involve himself with a large number of soil types varying only slightly from one to another. Clearly this would be useless for any practical purpose, and impossible to portray in any other than an excep-

tionally large and scaled map. It follows, therefore, that the array of gradually varying soil properties encountered in the field must (in imagination) be arbitrarily "chopped" at the most convenient places into a limited number of segments, which are described carefully and labelled as the soil types (or sub-types).

A soil type may therefore be thought of as a reasonably uniform piece of land, and its many repetitions here and there which include a number of closely similar though not identical profiles. It is, in effect, a collective unit, a bunch of **very similar soils**, among which is a most frequently represented and typical profile, and between which there exists a clearly recognised range of variation in soil properties. Indeed, if this variation within the soil type was not permitted, it would be impossible to map the soils. The practical question at the commencement of the survey is, therefore, how much variation is to be permitted within each soil type, and in consequence how many soil types shall be established. For, if distinctions are drawn too finely, so that too many types are created, then, although each will be admirably uniform within itself, the list of soil units (the Legend) will be so cumbersome, and the map so intricate, that its use will be discouraged. If, on the other hand, too few soil types are created, so that the variability within each is too great, then the results of agricultural experience and experiment on one part of a soil type may not be applicable to its other parts—and that would detract seriously from the usefulness of the map. Obviously, to decide on these points calls for compromise and nice judgment; and at this point, one might say, soil surveying is as much an art as a science.

Types and Series

The relationship of the soil types to one another, and to the series into which they are grouped, can be made clearer by considering the soils of a terraced river valley (See Fig. 2). These soils have formed on four distinct geographic sites, and consequently differ greatly in age and profile development. It will be obvious, therefore, that the soils of any one soil type (which by definition must be closely similar in profile character) can only occur on **one** of these sites, and on any **corresponding** sites in the same and similar valleys in the district.

The oldest of these soils are those on the gently sloping hillsides, formed in the mantle of weathered materials derived from the underlying rock. They have rested there so long that they have developed mature profiles, with characteristics determined, as a rule, by the local climate and vegetation. They are the zonal soils of the region—may be Yellow Grey Earths, if developed in the climate of the Canterbury lowlands. They differ in many ways from the younger soils formed on the alluvial terraces. It is even possible that their parent material, the bedrock, is different from that from which the alluvial terraces are derived. Their soil types will only be found on this kind of site, within the one climatic region; and the distinction between the soil types in this case is mainly on account of differences in slope and elevation—unless changes in the parent rock add further distinctions.

The soils on the three alluvial benches or terraces differ from the hillside soils and resemble one another, in that they certainly have one common parent material (or possibly one common mixture of parent materials); they are all nearly flat, and have not

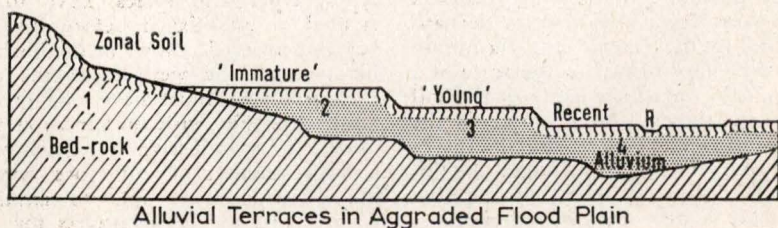


Fig. 2.

rested there long enough to have acquired, by weathering, leaching, panformation and other soil processes, the mature character of zonal soils. Nevertheless, they differ significantly in age from terrace to terrace, and therefore in profile development and fertility, and may be regarded as a maturity sequence; or "soil suite".

The Recent soils of the present flood plain are the youngest, the least weathered and least depleted by leaching. They are, therefore, in general, the most fertile. Moreover, they are still subject to rejuvenation (mineral additions) by fresh flood deposits, by which they are being kept youthful and fertile. Because of their close similarity in origin and age, most of these soils would be grouped together into one series, which, in the Canterbury lowlands, would be known as the Waimakariri series. But they are not all equal in agricultural value. Like all alluvial soils, they are patchy, and range from deep retentive silt loams and sandy loams (some of the most fertile soils we have) to shallow droughty soils on gravel, and in places become little more than old gravelly river beds. It is mainly on account of these differences in texture and depth that the series is split up into its soil types. In this case the Waimakariri series includes such soil types as Waimakariri silt loam, Waimakariri sandy loam, Waimakariri stony sand, and so on.

It is in this way that a soil type acquires the two parts to its name. The first is its series name which is merely a convenient label, derived from some place, county or river near which the soil was first recognised and named; and the second part is descriptive of the characteristic texture and depth of the soil.

The "Young" soils of the second terrace level likewise possess certain common properties due to their greater age, and the fact that they have been beyond reach of flood waters for several thousand years. They are, therefore, slightly leached of their

nutrients by many winter rains; and so, by comparison with the Recent soils, are more acid and less fertile. Once again, alluvial deposition has left them patchy, while some areas may suffer from seepage and poor drainage. This would usually lead to their division into two or more series by which the well drained are distinguished from the poorly drained soils, each series being given its geographic label or series name. These, in turn, are split up into soil types in the most convenient and useful manner, so taking account of differences in texture and depth that significantly affect their agricultural use. In a detailed survey (at 40 chains/inch) finer differences still, as for example of stoniness, wetness or peatiness, might often be distinguished and mapped separately as sub-types or phases.

Finally, the soils of the highest terrace, owing to their greater age (which could well be 50,000 years or more) are much more weathered and leached, acid and depleted of nutrients, and possibly have developed a clay or iron pan, which impedes their drainage in places. It is likely, too, that they will long have been developing under forest, in contrast to the grass and scrub, the natural vegetation of the younger terraces. Quite obviously, no soil type located on these high terraces could also occur on any of the other three sites, but only on this and any corresponding high terraces of similar age, origin and vegetation, within the same climatic and geographic region.

Perhaps enough has now been said to enable the reader to visualise a soil type as a reasonably uniform piece of land, and its many repetitions in corresponding situations here and there (sometimes extensive, sometimes in odd small patches), that include a number of closely similar but not necessarily identical soil profiles, whose geological origin, age, natural soil development and agricultural behaviour are for all practical purposes the same.