SOILS IN CANTERBURY.

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IT will not be possible in this paper to deal with *more* than the most **extensive** soils of the Canterbury plains; a few of the numerous pther types will be mentioned in passing.

The basis for soil surveys nowadays is **the soil profile,** which is a Section through topsoii, subsoil, and the underlying parent material from which the soil has been formed, i.e., the kind of section one sees in a road cutting or in a post hole. The factors which determine the kind of Profile formed at any given spot are: **parent rock, slope, climate, plants, and animals,** and the **time** these factors have been in operation. To get an idea of the kinds of soil in canterbury and the way these have been classified it is necessary to refer briefly to the factors mentioned above.

(a) Parent rock: Most of Canterbury consists of greywacke rock either in its original possition or broken up and transported elsewhere by rivers and winds. Other parent materials of importance are mudstones, limestones, volcanics, and peats.

It is not out of place here to give an abbreviated account of the formation of the plains, a full description of which may be seen in "Natural History of Canterbury." Probably at one time the sea beat along the foot of the Alps, which were then in the form of an elevated peneplain" (undulating surface),. The major rivers carved their way down into the underlying rock and carried out the products of this geological erosion to form large shingle fans which grew in. size until eventually they linked up. Later the rivers cut deeply into their fans, producing a succession of terraces down to the present-day river-beds (see Fig. 1). In depressions lying between these great fans sprang up the smaller streams-the Eyre, Selwyn, and Hinds.

Large glaciers,, remnants only of which now remain, built out moraines along the foot of the hills. In times of thaw the swollen rivers- flooded, -depositing--fine glacial rock flour. North-west winds dried this out and blew it 'away over the adjoining land and into the ocean. Banks Peninsula, then a volcanic island in the sea, was covered with wind-blown glacial flour derived from the greywacke mountains of the Alps; and so today we find that although the peninsula was once volcanic,' only the steepest of slopes have given rise to soils of volcanic origin, by far the greater area being occupied by soils formed from greywacke dust carried by wind from the Canterbury Plains.

(b) **Slope:** On steep slopes the soils are constantly. being rejuvenated by geological erosion (not by man-promoted erosion, which removes the soil altogether), Gentle **slopes and** flats do not undergo rejuvenation fast enough to keep. pa; with the effect of climate and living organisms which are striving to ma e the soil more mature. Slope has also played a part in soil formation on the Canterbury Plains (see Fig. 2).

(c) **Climate:** Rainfall varies from 25in. near-the sea to 40in. along the foot of the hills and to over 200in. on the top of the Alps. Greater rainfall on soilof the same parent material, slope, and age causes greater leaching of plant foods. .

(d) **Plant and animal life:** Native vegetation consisted of:—

1: Dry land: Poa and festuca tussocks? manuka, New Zealand broom, occasional cabbage trees.

2. Swamps: Raupo, niggerhead, phormium flax.

3. Better-drained land: Manuka, kahikatea.

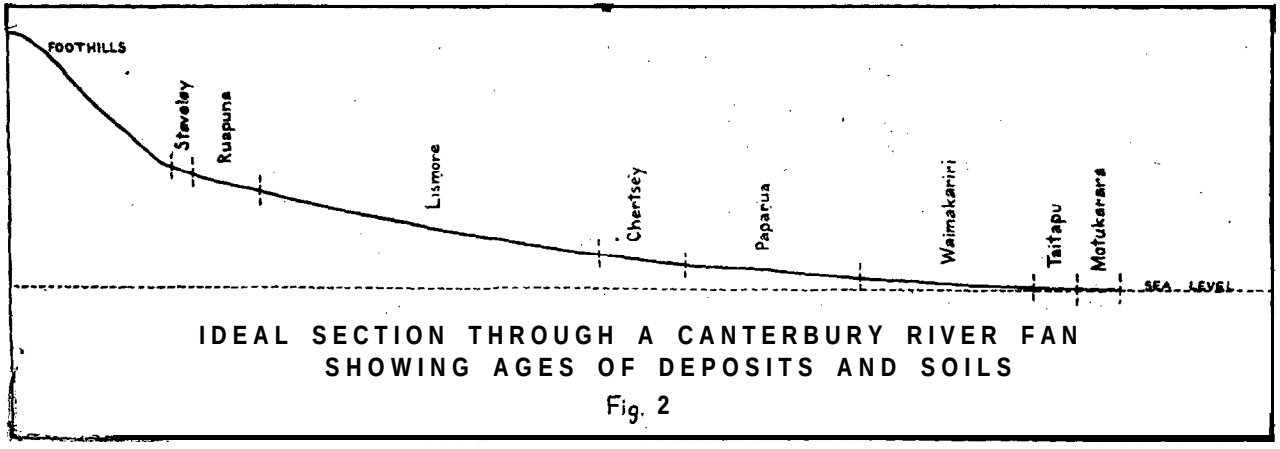
4. Foothill plains land: Black beech (*Nothofagus solandri*).

Domestic animals and man have caused loss of topsoil through erosion on the plains as well as on the downs and hills. Heavy cropping is known to cause a deterioration in soil structure and a drain on plant nutrients, thus leading to a fall in fertility; but declining yields, which should be readily seen, are offset by better seed, manuring, etc., thus obscuring temporarily the loss of fertility in the soil itself.

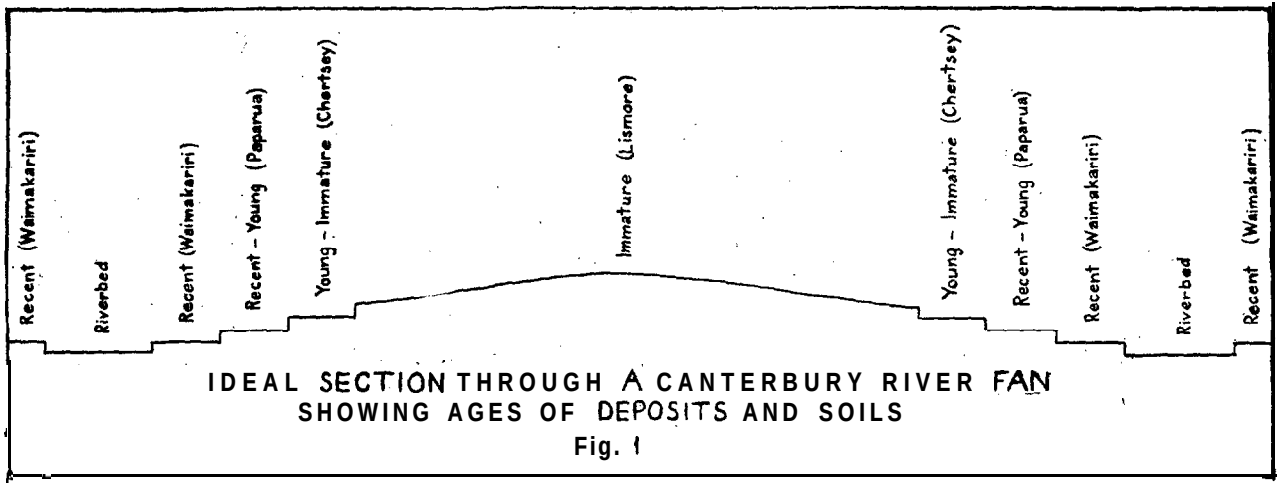
(e) **Time:** Last, the soils are greatly influenced by the time for which the other factors-parent rock. slope, climate, plants, and animals — have been -acting--upon- them: Thus the oldest parts of the plains, midway between and highest above the rivers, have been much more leached of their plant foods than have the younger soils at lower levels near the rivers (see Fig. 1).

Soils

Soil maps of parts of Canterbury have already been published. Bulletin No. 92 of the Department of **Scientific**



IDEAL SECTION THROUGH A CANTERBURY RIVER FAN
SHOWING AGES OF DEPOSITS AND SOILS
Fig. 2



IDEAL SECTION THROUGH A CANTERBURY RIVER FAN
SHOWING AGES OF DEPOSITS AND SOILS
Fig. 1

and Industrial Research deals with 10,000,000 acres of South Island "high country," most of which supports, or used to support, tussock vegetation. Roughly half this area lies in Canterbury, where 8 widely different kinds of soil have been recognised and mapped. "High country," for purposes of investigation, is a misleading term in that it suggests. that there is only one kind of soil present. These soils differ from each other as to their colour, texture, depth, chemical composition, altitude, climate, plant cover. and erodibility. When these differences have been so clearly demonstrated it is unfortunate that some research workers and others continue to use that archaic, omnibus term "high country" when they could refer to the soils present by the names that have been given to them. There are few who would refer to the many different soils on the Canterbury Plains as merely "plains soils."

Bulletin No. 65 of the same Department covers 21,000 acres of the western slopes of Akaroa Harbour. On the hills 10 soil types are recognised, indicating how parent substance, vegetation, slope, rainfall, etc., all play a part in forming different soil types.

A soil map and text covering Ashburton Plains were published in the annual report of the Soil Survey for 1934-35. It was followed by a farm management map of the same area by Mr. J R. Fleming (Department of Scientific and Industrial Research Bulletin No. 58) which shows the very close correlation between type of soil and type of management. This soil map has also provided a useful background for the carrying out of further surveys on the plains.

In the 1935-36 annual report of the Soil Survey appears a detailed map of the Levels Plain. There are other miscellaneous publications dealing with various aspects, e.g., linen flax growing, erosion on the downs, etc., but I do not propose to outline them here.

Field work on a survey of the plains and downs between Herbert in the south and Waipara in the north (more than 5000 square miles) is now completed, but some months' office work is still required It was hoped to release advance copies about the middle of 1949. These will be available to institutions -like Government departments. Lincoln- College; and the local catchment boards, but they will not be available to private individuals until they appear in printed form.

The **soils of the downs** have been divided into 15 series, but only 10 occupy any great area of land. These 10 series are derived mainly from wind-deposited glacial silts in the same manner as most of Banks Peninsula. A cut across the downs near Timaru shows that near the coast a well-defined "pan" is in evidence, but that inland the "pan" gradually disappears, fertility falls off, and the soils (silt loams on heavy silt-loam subsoils) become more acid.

The **soils of the plains** donsist of 31 series, which in turn may be divided into further types and phases. Fig. 3 shows a very generalised picture of more detailed mapping between the Waimakariri and the Rakaia Rivers.

Series 1 to 6 are recent soils of high plant food content.

1. The Waimakariri series is chiefly sandy loams and sands of varying depths to stones. Fertility is limited by dryness, but where more silt occurs in the profile and moisture retention is better, good yields of grain are obtained. The driest parts, which carry hairgrass, danthonia, stipa, etc., are well suited to the growth of subterranean clover.

2. The Motukarara series occurs near Lake Ellsmere and contains salt, but in most other characteristics it resembles Waimakariri. Near the lake, where salt content is highest, pasture species will not survive; but further away from the water's edge the effect is less intense and a concentration to toxic proportions occurs only in the driest seasons when excess evaporation leaves salt on or near the surface. Passing fresh water through this soil is said to -have reduced salinity somewhat over a period of years.

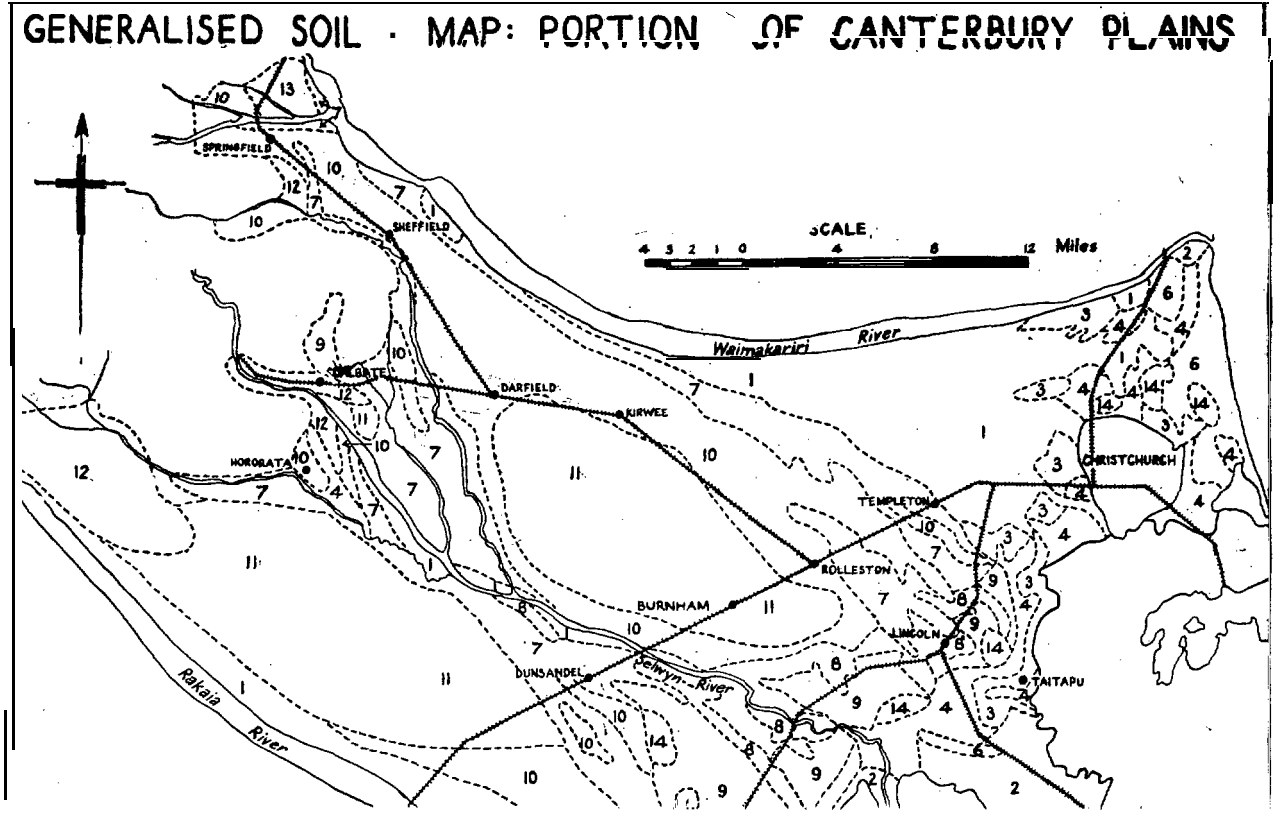
3. The Papanui and Kaiapoi series are similar to Waimakariri except that they contain adequate moisture and are -therefore much more fertile. Papanui consists of sandy loams and Kaiapoi of silt loams, and both can maintain good permanent pastures.

4. The Taitapu series is similar to Kaiapoi except that it contains moisture in excess, which causes crops to lodge: badly in wet seasons. There are some paddocks which have been in grass for more than 25 years. Top-dressing does not appear to be a common practice; but' further trials should be carried out to see what can be done in this line. The fertility is very high, but most pastures contain a great deal of browntop.

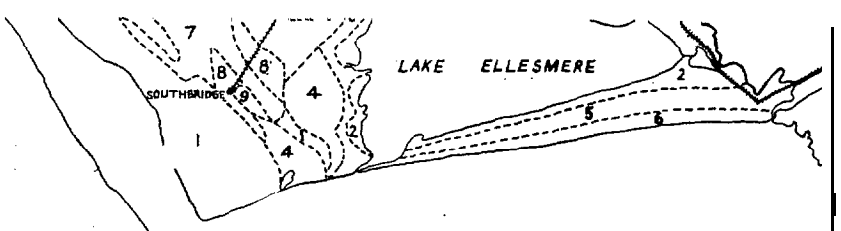
5. The Taumutu series is the name given to the boulder-bank soils bordering Lake Ellesmere. Depths vary from place to place, but where sufficient soil is present it is quite a good farming proposition.

6. The Kairaki and Waikuku series occur on the coastal sand dunes. Near the sea, dunes are eroding freely, but the inland margin of this belt is well anchored by grass and can be grazed to a limited extent in association with the wet Taitapu soils nearby.

Series 7, 8, and 9 (see Fig. 1) lie higher above the rivers, are a little


GENERALISED SOIL · MAP: PORTION OF CANTERBURY PLAINS
SCALE
4 3 2 1 0 4 8 12 Miles
Waimakariri River
SPRINGFIELD
SHEFFIELD
DARFIELD
KIRWEE
HOROBATA
CHRISTCHURCH
TEMPLETON
ROLLESTON
BURNHAM
LINCOLN
DUNSANDEL
TAITAPU
Selwyn River
Rakaia River

Survey Department. Additional data compiled by C. S. Harris from soil maps, prepared by Department of Scientific and Industrial Research.



LEGEND

RECENT GROUP

1 Waimakariri — salt / moisture → 2 Motukarara; 3 Papanui and Kaiapoi — moisture → 4 Taitapu

5 Taumutu

6 Kairaki and Waikuku

RECENT TO YOUNG GROUP

7 Paparua and Templeton — moisture → 8 Ladbrooks and Springston — moisture → 9 Temuka

YOUNG TO IMMATURE GROUP

10 Chertsey and associated series

IMMATURE GROUP

11 Lismore — rainfall / altitude → 12 Ruapuna

PODSOLIC GROUP

Stavelev

ORGANIC GROUP

14 Waimairi

Traced by G.H. Morgan 1948.

Fig. 3

older than the foregoing, and show a more distinct development of topsoil and subsoil. They are very slightly leached 'of plant foods.

7. The Paparua (sandy loams) and Templeton (silt loams) series are both very fertile where the profile is deep, but Paparua is too dry to support permanent pasture where stones are near the surface. Both series are frequently cropped, and probably short-rotation ryegrass would perform useful fun&i& in encouraging Farmers to leave paddocks long enough in a high-producing pasture to let the soil recuperate.

8. The Ladbrooks and Springston series are the damp counterparts of 7 above and should both be able to carry permanent pastures. Fertility is high and cropping is frequent.

9. The Temuka series may be regarded as a wetter stage of Ladbrooks and Springston and iron pan occurs in places. Fertility is slightly lower than that of Taitapu and, from the chemical determinations that have been made, one would expect a better response to lime on Temuka than on Taitapu.

10. The Chertsey and associated series lie higher above the rivers than any of the foregoing, leaching of plant nutrients has proceeded further, fertility is lower, and lime requirement is higher. Many areas are shallow. and subterranean clover has a place; but the deeper parts yield heavy crops except in the driest seasons.

In bygone times great quantities of dust from the river-beds were lifted by strong north-west winds and deposited over the plains. This dust is sandy near the rivers, but the sediments become finer as distance from the rivers increases. Waimakariri and Paparua series both received a heavy dressing of sandy material, but Chertsey series, being further away from the rivers, received a topdressing of more silty materials. Because the prevailing dry wind was from the north-west, we find that the southern banks of Canterbury rivers consist of deeper and more fertile soils than do the northern banks.

11. The Lismore series lies on the tops of the oldest parts of the river fans., midway between the rivers (see Fig. 1). It is, in point of area, the most important on the Canterbury Plains. Between the Waitaki and Waipara Rivers there is about 675 square miles (approximately half a million acres) of this series of which some 400 square miles is soil about 12in. deep, The remaining 275 square miles averages about 5in. to 8in. in depth, as at Burnham. Topsoils are brownish grey to light grey, subsoils are yellow, and textures are silt loams throughout. Because this area has been exposed to leaching by rainwater for the longest period,, plant food content is low and acidity IS high. Chemical figures indicate an initial lime requirement of 2 to 3 tons of carbonate, but in two or three cases only have farmers applied such heavy initial dressings. Unimproved pastures are browntop and hairgrass. Mr. Leitch in his paper will no doubt include Lismore series with others under the heading of "light lands," and those who make the trip to the Winchmore Irrigation Station, which is on Lismore series, will be able to form their own opmions as to the value of irrigation on it.

12. The Ruapuna series for present purposes can be regarded as the "high-rainfall, bouldery phase" of the Lismore series. It lies at the inland extremity of the river fans. The soils are leached to about the same extent as Lismore, but the higher rainfall enables pastures to outlast Lismore paddocks in a dry season.

13. The Staveley series, a stony shallow soil lies between the foothills and the Ruapuna series. Rainfall is over 40in., and this was enough to support a beech forest cover.

14. The Waimairi series is a peat or peat-loam soil, not all of which has yet been adequately drained. This will be seen on the northern excursion, which follows the road over Marshland (Waimairi) soils, past market gardens.

Conclusion

Soil maps of part of Canterbury have already been published and advance copies of the plains and downs maps of the area between Herbert and Waipara will be available to big institutions about the middle of 1949. In later years it is proposed to follow up this work by detailed mapping of each county in turn.

The Department of Agriculture now picks out the spots for trial areas based. on the types of soil identified and mapped by the Soil Survey Division of the Department of Scientific and Industrial Research. This ensures that trials fall on typical areas of the types recognised and not on transitional, indefinite types, which are much less widely representative It means that we can now drop such terms as "heavy wet pea land," "light land," "barley land," and so on, referring instead to "Temuka silt loam," "Lismore silt loam," "Waimakariri sandy loam, shallow phase," etc. By reference to maps we can see the location and extent of any soil type in question and know just 'where results from trials, or from farmers' experience, are applicable.

At first a soil map appears rather complicated. It is. The map IS intendeed to meet 'practically every requirement, but it can be greatly simplified for any given purpose.