

five large districts, which were called "meridional circuits," mostly bounded by conspicuous natural features. In each circuit a station called an "initial station" was chosen, central where possible; and latitude and true meridian were there observed for with an eight-inch transit theodolite, the one by circum-meridian zenith distances of north and south stars, and the other by equal altitudes of stars east and west.¹ Then, from the initial point, long angular traverses, following the chief valleys suitable for settlement, were carried, without chaining, in various directions to the boundary of the circuit. The points on these traverses, styled "geodesic" stations, were usually from ten to fifteen miles apart; and the bearings of the traverse lines, all referring to the meridian of the initial station, became fundamental bearings for all subsequent surveying operations in that circuit. Wherever the lines of adjacent circuits met on the common boundary a comparison of bearings was made, and it is evident that the difference should be equal to the convergence of the tangents to the meridians at the initial stations of the two circuits.

For the third process, each circuit is divided in the office into "districts" about twelve miles square, their sides usually being parallel and perpendicular to the central meridian. Then, in each district, a base line from one to five miles long is measured three or four times with a standard chain; the accuracy of which can at any time be verified by reference to one of the various 66-foot standards which have been laid down from a three-foot brass scale at suitable points in the province. On the base line a small triangulation is constructed, with sides from two to three or four miles long,² and connected with the lines of the circuit traverse; the angles are taken from every station, on three arcs; the maximum of permissible error in the sum of the observed angles of a triangle is 1', and there is no distribution of error. Vertical angles are also observed. Trigonometrical stations near the boundaries are used by the surveyors of the surrounding districts. From the reduced horizontal angles the direction of every line with respect to the meridian of the initial station is found, and thence the co-ordinates of each station on parallels and perpendiculars to the meridian, which form the *data* for plotting. The survey of each circuit is thus regarded as a plane survey spread out on either side from the initial meridian. Concurrently with his triangulation, the district surveyor makes a topographical sketch of the country; the principal features, existing roads, &c., being inserted by means of intersections and eye. All is now plotted and drawn on the scale of two inches to a mile, and the suggested lines for future roads are marked on the plan before sending it to the office. The district is then divided in the office into "blocks" about three miles square.

Last comes the "section survey," or subdivision of the blocks for occupation. In this, after laying out and marking the block boundaries, the surveyor designs and lays out his roads, connecting all traverses with the sides of the triangulation; and plots them on the block plan on the scale of eight inches to a mile. Then he designs the sections on the plan, their shape, size, and arrangement depending on the course of roads and "lay" of country, but they are usually quadrilaterals of from 40 to 300 acres. In laying out roads and sections, topographical details are also surveyed. About one-tenth of the plans are examined on the ground, the rest in the office only. When passed, the plan is published on a reduced scale by photo-lithography, and copies are issued to the necessary quarters as an index for the public in selecting land for purchase.

From the finished block plans Crown Record maps are constructed, on the scale of four inches to a mile, the trigonometrical points being scored, and the detail reduced by a pentagraph. Each record map usually embraces a "district," or series of blocks—usually from twelve to sixteen block-plans. The number of each section, name of original grantee and other detail are shown on it, and copies of the necessary parts are made and transferred to the grants. The record maps and most of the block plans are in a good state: the latter in some cases become so worn that duplicates have now and then to be made, but with these exceptions there is no preparation of duplicates.

On the general plan described above, about 7,000,000 acres have been triangulated and topographically sketched, leaving 9,038,400 acres untouched,³ two-thirds of which is however little but mountain and forest; and 2,800,000 acres have been section-surveyed. These figures include Southland; but as that province, after union with Otago, was brought as far as possible under the general system, the isolated surveys which were required could fortunately be connected in most cases with the triangulations, and placed sufficiently well on the topographical maps to prevent confusion and overlaps. All the work hitherto done may accordingly be considered fairly accurate, showing that, as an expedient for promoting rapid and correct land sales, and preventing waste, the Otago system has answered well. Indeed, both of the cardinal branches, trigonometrical and detail, have been surrounded with most of the safeguards and precautions which should be looked for in a well-managed survey department. All original records, moreover, have been carefully kept and registered, and the trigonometrical stations, with few exceptions, are erect and permanently marked; so that every part will be available for further use if required.

When, as the surveys within circuits progressed, the various initial points came to be connected together by intervening minor triangulations, it became possible to test the accuracy of the work by making comparisons between the observed differences of latitude and the differences com-

¹ A method I by no means recommend.

² In some of the more mountainous districts the sides are from five to seven miles long.

³ Except that a reconnaissance was made of 4,000,000 acres of it.