APPENDIX "F."

TRIANGULATION OF WESTERN AUSTRALIA.

(Contributed by H. F. Johnston, Esquire, Surveyor-General, Western Australia.)

The bulk of the Triangulation work was carried out between the years 1882 and 1887, the instruments used being 6″ and 8″ vernier transit theodolites.

(2) More modern work is as follows :—

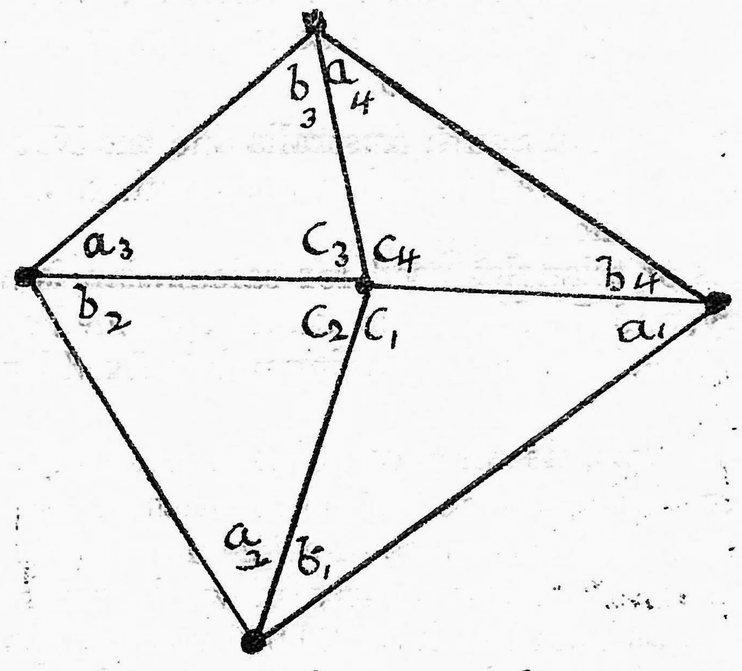
(*a*) Mount Margaret Goldfields triangulation and two Base lines, 1899.
(*b*) Kimberley triangulation and Base line, 1904, 1905, and 1907.
(*c*) De Grey triangulation revision and Base line, 1906.
(*d*) Marble Bar triangulation, 1909.
(*e*) Triangulation, Rottnest Island to Mount Bakewell, and measurement of the Rockingham and Jennaberring Base lines, 1910.

The instruments used on (*a*) (*b*) (*c*) and (*d*) were 6″ and 8″ theodolites.
Base lines (*a*) measured on the beds of Lakes Carey and Raeside with steel bands 500 links long.
Base lines (*b*) and (*e*) measured with invar bands.
Base line (*c*) measured on the surface of the ground with an invar band, 500 links long.

(3) Triangulation (*e*) covers an area of about 3,000 square miles, and the angles were read with a 6″ transit theodolite, fitted with micrometer microscopes for reading the circles.

Maximum error of close equals 4·1″.
Average ,, ,, ,, 2·4″.

Method Adopted in the Adjustment of Error of Observation.



In the figure, let a_1, b_1, c_1, a_2, b_2, c_2, a_3, b_3, c_3, a_4, b_4, c_4 represent the observed angles in each of the triangles in the above figure.

Then $(a_1 + b_1 + c_1) - (180° + \text{spherical excess}) = e_1$ represents the angular error of the triangle $a_1\ b_1\ c_1$. Similarly $(a_2 + b_2 + c_2) - (180° + \text{spherical excess}) = e_2$ is the angular error of the triangle $a_2\ b_2\ c_2$, and so with the triangles $a_3\ b_3\ c_3$ and $a_4\ b_4\ c_4$, the errors being represented by e_1, e_2, e_3, and e_4.

Again, $c_1 + c_2 + c_3 + c_4 - 360° =$ the central error $= e_c$.

$$\text{The side error} = 4 \times \frac{\text{sum of log sines of } a_1\ a_2\ a_3\ a_4 - \text{sum log sines } b_1\ b_2\ b_3\ b_4}{\text{sum of log changes for } 1'' \text{ in a and b angles.}}$$

Let the side error $= e_s$.

Then for the triangle $a_1\ b_1\ c_1$ the angular corrections to be applied when x, y, and z = the errors in the angles—

$$x = \frac{-e_c + 4e_1 + 2e_s}{8} \qquad y = \frac{-e_c + 4e_1 - 2e_s}{8} \qquad z = \frac{e_c}{4}$$

and the corrected angles $= a_1 - x$, $b_1 - y$, and $c_1 - z$.

In triangle $a_2\ b_2\ c_2$—

$$x = \frac{-e_c + 4e_2 + 2e_s}{8} \qquad y = \frac{-e_c + 4e_2 - 2e_s}{8} \qquad z = \frac{e_c}{4}$$

the corrected angles being $a_2 - x$, $b_2 - y$, and $c_2 - z$, and similarly with the other triangles. If, after this adjustment, the sum of the log sines of the a angles differs from the sum of the log sines of the b angles by a quantity d, a slight correction is applied to each of the a angles, and a similar correction to each of the b angles, but with the opposite sign ; this correction is found by dividing d by the sum of the log changes for 1″ in the a and b angles.

Base Lines.

Base lines are now measured in Western Australia with invar bands, 500 links long, supported on tripods at intervals of 125 links. The tape is graded from point to point by means of sliding vanes on rods, and, being suspended in the air well above the surface of the ground, the element of doubt regarding its actual temperature is largely removed, and the errors resulting from this cause are practically negligible.

Irwin Base Line—Sections.

Chainage.		1st Measure.	2nd Measure.	No. 1 – No. 2.	Length of Section in Links.
From—	To—	Corrections in Inches.	Corrections in Inches.	Difference in Inches.	
0	4,000	20·601	20·583	+ ·018	4,000
4,000	10,500	25·031	24·898	+ ·133	6,500
10,500	18,500	13·124	13·020	+ ·104	8,000
18,500	28,000	19·731	19·682	+ ·049	9,500
28,000	36,500	11·213	11·375	– ·162	8,500
36,500	48,500	63·723	63·733	– ·010	12,000
		– 153·423	153·291	+ 0·132	48,500

The above corrections are for scale readings, sag inclination, and temperature.

The probable error of the mean of the two measurements equals 1 in 5,800,000, not including the error in the length of the tape.

Recent Triangulation.

In May, 1909, a trigonometrical connexion was effected between the De Grey and Marble Bar Triangulations.

Five new stations were erected, and observations taken for Azimuth at △ F2. The angles were read with a 6″ vernier transit theodolite with an average error of close of 5·4″ per triangle.

This connexion embraced a series of nine triangles.

In September, 1910, an important trigonometrical connexion was completed between the old coastal triangulation in the vicinity of Fremantle and △ Mount Bakewell, near York. The angles were read with a 6″ micrometer theodolite with an average error of close of 2·4″ per triangle.

Eight triangles were required to effect this connexion.

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