CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

NATIONAL MUSEUM OF CANADA
W. H. COLLINS, ACTING DIRECTOR

BULLETIN No. 57

A Transverse Polyconic Projection for General Maps of Canada

BY

C.-O. Senécal
Geological Survey, Canada

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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A TRANSVERSE POLYCONIC PROJECTION FOR GENERAL MAPS OF CANADA

The ordinary polyconic projection, invented by Professor Ferdinand Hassler, first Superintendent of the United States Coast and Geodetic Survey, owes its popularity in United States and Canada, to the facility of its construction from elaborate tables published by that institution, the United States Geological Survey, the Smithsonian Institution, and others. But it has the grave drawback of introducing on maps, increasing errors in meridional distances as meridians recede from the central meridian. Its use is recommended for maps covering any distance north and south, but limited east and west to such extent that the distortion is at a minimum consistent with the purposes of the maps.

The projection is, therefore, unsuited for a map of the whole of the Dominion of Canada whose great east-west dimension is predominating and whose site is in high latitudes. However, it seems that a polyconic projection in a *transverse* position, as suggested by Charles H. Deetz (U.S.C. and G. Survey Spec. Pub. No. 47), with the poles assumed—for construction only—to be transferred to the equator, and the middle meridian of the country taken as *auxiliary* equator, may be used with advantage for a general map of Canada. On account of the shape of the country, the greatest distortion and largest errors, inherent to the projection, would fall outside its boundaries; the general properties of the polyconic system would be preserved, and, by the fact that angles subtending the developed contact bases of the tangent cones would be smaller than in the ordinary projection, the consequent curve deflexions affecting the length of arcs of parallels of latitude, would also be smaller, and tend to lessen those errors.

The following computation of a *transverse polyconic projection* is, therefore, undertaken in the hope that it may serve a useful purpose, and interest the general map draughtsman to whom this paper is dedicated. Elementary knowledge only of plane and spherical trigonometry is required for the transformation of rectangular co-ordinates and no mathematical discussion of this projection will be entered into.

The problem may be worked out on the hypothesis of a *spherical* earth whose radius would be such that the surface of the map-area would *most nearly* coincide with the corresponding ellipsoidal surface of the earth. The radius of such a sphere is equal to the geometrical mean of the meridian radius of curvature, and the radius of curvature of the normal section of the earth ellipsoid at the latitude of the centre of the area considered:

$$r = \sqrt{\rho_m \, \rho_n}$$ [1]

But this applies to relatively small areas only, as errors with contrary signs are introduced in meridional and parallel distances. On a map of the whole of Canada, unless the scale be very small, such errors are inadmissible.

[1] Germain, A.: Traité des Projections des Cartes Géographiques.

In order to take into account the flattening of the pole, i.e. to preserve, as far as possible, correct meridional distances between latitudes, and to eliminate extreme errors on maps of moderately small scales, a process may be evolved on the same hypothesis in the assumption of a series of spheres whose radii would gradually increase with the latitudes, so that the least errors would be found in the lengths of corresponding parallels. Such a conventional projection would be the result of a superposition or assemblage of separate projections of zones of different spheres, closely approximating natural surfaces comprised between common axes of rectangular co-ordinates and the parallels of latitude, whereby true distances would be held, at least, on the central meridian.

The meridian of longitude 95 degrees west from Greenwich, is chosen as the central meridian—or *auxiliary* equator—and the intersection of the parallel of latitude 60 degrees with this meridian, as the origin of rectangular co-ordinates. The unit of distances for the computation is the statute mile.

DETERMINATION OF THE RADII OF THE AUXILIARY SPHERES

The radii of the successive spherical zones are determined from the true lengths of meridional arcs measured from the origin of co-ordinates at latitude 60 degrees to the successive intersections of parallels of latitude. These meridional distances may be calculated by the standard formula in geodesy, but a more expeditious method is to compute them from tables given in Special Publication No. 5 of the U.S.C. and G. Survey, thus:

Denoting by $m_1\ m_2\ m_3 \ldots . m_n$, the lengths of single degrees of latitude north of latitude 60 degrees; by $m_{-1}\ m_{-2}\ m_{-3} \ldots . m_{-n}$, those south of latitude 60 degrees as found in the tables, and by $M_1\ M_2\ M_3$ .... etc., the meridional distances, we have:

Between lat. 60° and lat. 61°, (1 degree): $M_1 = m_1$
" " 62°, (2 degrees): $M_2 = m_1 + m_2$
" " 63°, (3 degrees): $M_3 = m_1 + m_2 + m_3$
" " (60 + n)°, (n degrees): $M_n = m_1 + m_2 + m_3 + \ldots\ldots\ldots + m_n$

and likewise:

Between lat. 60° and lat. 59°, (1 degree) : $M_{-1} = m_{-1}$
" " 58°, (2 degrees): $M_{-2} = m_{-1} + m_{-2}$
" " 57°, (3 degrees): $M_{-3} = m_{-1} + m_{-2} + m_{-3}$
" " (60−n)°, (n degrees): $M_{-n} = m_{-1} + m_{-2} + m_{-3} + \ldots\ldots + m_{-n}$

Denoting by $r_1\ r_2\ r_3 \ldots\ldots r_n$ and $r_{-1}\ r_{-2}\ r_{-3} \ldots . r_{-n}$, the radii of spheres corresponding to those meridional arcs, we have

$$r_1 = M_1\ (360/2\pi)$$

$$r_2 = \frac{M_2\ (360/2\pi)}{2}$$

$$r_3 = \frac{M_3\ (360/2\pi)}{3}$$

$$\vdots$$

$$r_n = \frac{M_n\ (360/2\pi)}{n}$$

$$r_{-1} = M_{-1}\ (360/2\pi)$$

and

$$r_{-2} = \frac{M_{-2}\ (360\,/2\pi)}{2}$$

$$r_{-3} = \frac{M_{-3}\ (360\,/2\pi)}{3}$$

$$\vdots$$

$$\vdots$$

$$r_{-n} = \frac{M_{-n}\ (360\,/2\pi)}{n}$$

or, expressed in logarithms

$$\left.\begin{array}{l} \log r_n = \log M_n - \log n + [1{\cdot}7581226] \\ \log r_{-n} = \log M_{-n} - \log n + [1{\cdot}7581226] \end{array}\right\} \quad (1)$$

and

The radius of sphere to be used for the parallel of latitude 60 degrees, is the meridian radius of curvature of the earth ellipsoid at that latitude which is found in the Smithsonian Geographical Tables, but may be calculated by above formula, from the arc of 1 degree between latitude 59° 30′ and latitude 60° 30′.

TRANSFORMATION OF RECTANGULAR CO-ORDINATES

This problem is solved as follows:

In Figure 1, let the central meridian of the projection—the axis of

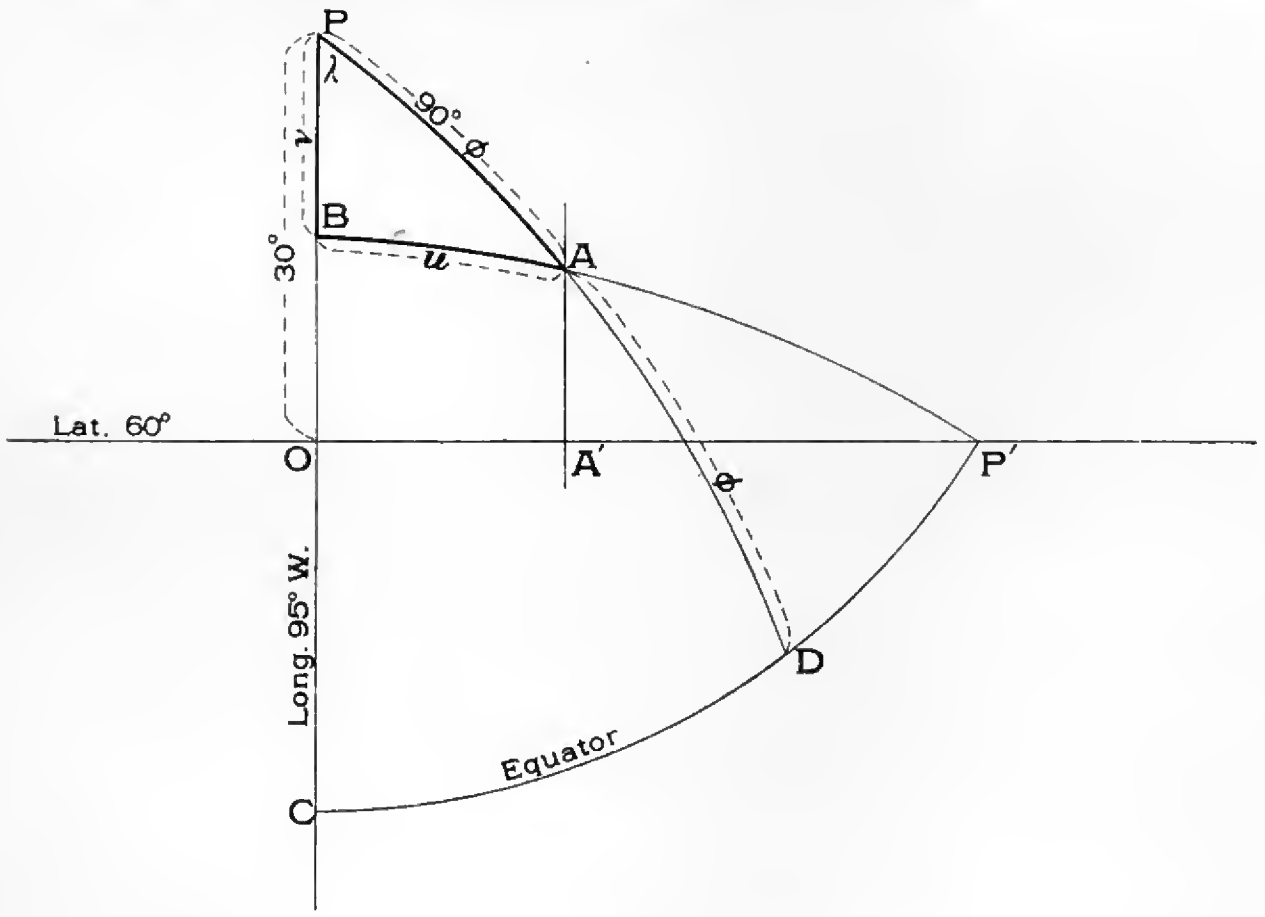


Figure 1.

ordinates—be represented by the line $C\ O\ P$; the rectified arc of great circle $O\ A'\ P'$, perpendicular to the central meridian at latitude 60 degrees to be taken as axis of abscissæ with the intersection O, as origin of co-ordinates. The arc $C\ D\ P'$ represents the equator, and point P, the pole.

Let A be a point on the earth's surface whose latitude and difference of longitude with the central meridian are respectively ϕ and λ. Through point A, draw an arc of great circle $P'\ A\ B$ perpendicular to the central meridian, and an arc of small circle $A\ A'$, parallel to the central meridian. The arc of great circle $D\ A\ P$ perpendicular to the equator represents the meridian of point A.

In the right-angle spherical triangle $A\ B\ P$, formed by those arcs of great circle, we have the following relations:

$$\begin{aligned} \sin u &= \sin (90^\circ - \phi) \sin \lambda \\ &= \cos \phi \sin \lambda \end{aligned} \qquad (2)$$

$$\begin{aligned} \tan v &= \frac{\cos \lambda}{\cot (90^\circ - \phi)} \\ &= \cos \lambda \tan (90^\circ - \phi) \\ &= \cos \lambda \cot \phi \end{aligned} \qquad (3)$$

Now, in a polyconic projection of various points, A, laid in a transverse position, the pole P being transferred to P' on the equator, and the apexes of the tangent cones lying on the axis of abscissæ, the values (2) and (3) may be assumed, for purpose of computation, to be the *auxiliary* latitude and longitude respectively as elements of the formulæ of the regular polyconic development. Thus, we have from Figures 1 and 2:

$$\begin{aligned} r &= \text{radius of spherical zone} \\ l &= r \cot u \\ \begin{cases} \alpha = (30^\circ - v) \sin u & (\text{where } v < 30^\circ) \\ \alpha = (v - 30^\circ) \sin u & (\text{where } v > 30^\circ) \end{cases} \end{aligned}$$

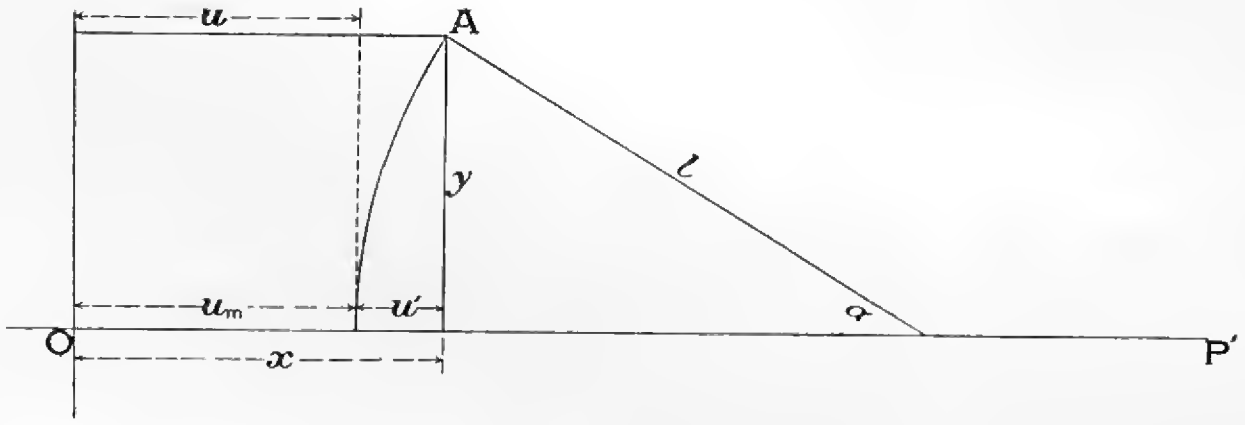


Figure 2.

$$u' = 2l \sin^2 \frac{\alpha}{2}$$

or

$$u' = 2r \cot u \sin^2 \frac{\alpha}{2}$$

The length of arc u in statute miles is given by the formula

$$u_m = 2\ \pi\ r\ \frac{u}{360}$$

The abscissa is then expressed by

$$x = u_m + u' \qquad (4)$$

and the ordinate by

$$y = l \sin \alpha$$

or

$$y = r \cot u \sin \alpha \qquad (5)$$

When the projected points are situated to the north of the axis of abscissæ, that is to say, when arc v is smaller than 30 degrees, the colatitude of the origin of co-ordinates, the y values are given the sign +; when the projected points are to the south of the axis of abscissæ where arc v is greater than 30 degrees, the ordinates y are distinguished by the sign −. The ordinates are to be plotted accordingly above or below the axis of abscissæ. The x values are scaled east and west of the central meridian.

Each parallel of latitude is thus separately computed, developed, and projected in the same manner, point by point, the radius of the corresponding spherical zone from formula (1) being used as above explained.

Derived from the above formulæ, the latitude spacings on the different meridians are kept in nearly true distances in the central part of the projection. On the outskirts, the meridians and parallels increase in length, but the greatest distortion falls mostly beyond the limits of the country.

Numerical Example. Suppose $\phi = 65°$ and $\lambda = 40°$, what are the co-ordinates x and y?

From the table, the meridional distance between latitudes 60° and 65°,

is ..... $M_5 = 346 \cdot 280$ statute miles
$\log M_5 = 2 \cdot 5394274$
$\log 5 = 0 \cdot 6989700$
$1 \cdot 8404574$
constant $= 1 \cdot 7581226$
$\log r = 3 \cdot 5985800$

$\log \cos 65° = \bar{1} \cdot 6259483$
$\log \sin 40° = \bar{1} \cdot 8080675$
$\log \sin u = \bar{1} \cdot 4340158$
$u = 15° 45' 45'' \cdot 72 = 56745'' \cdot 72$

$\log u$ (in seconds) $= 4 \cdot 7539332$
$\log 2\pi = 0 \cdot 7981799$
$\log r = 3 \cdot 5985800$
$9 \cdot 1506931$
$\log$ circumference (secs) $= 6 \cdot 1126050$

$\log$ (u in miles) $= \log u_m = 3 \cdot 0380881$
$u_m = 1091 \cdot 662$ miles

$$\begin{aligned}
\log \cos 40^\circ &= \bar{1}\cdot 8842540\\
\log \cot 65^\circ &= \bar{1}\cdot 6686725\\
\log \tan v &= \bar{1}\cdot 5529265\\
v &= 19^\circ\ 39'\ 26''\cdot 48
\end{aligned}$$

$$\begin{aligned}
\log\ (30^\circ - v) = \log 37233''\cdot 52 &= 4\cdot 5709341\\
\log \sin u &= \bar{1}\cdot 4340158\\
\log \alpha &= 4\cdot 0049499\\
\alpha = 10114''\cdot 62 &= 2^\circ\ 48'\ 34''\cdot 62\\
\frac{\alpha}{2} &= 1^\circ\ 24'\ 17''\cdot 31
\end{aligned}$$

$$\begin{aligned}
\log \sin \frac{\alpha}{2} &= \bar{2}\cdot 3894509\\
\text{“ “} &= \bar{2}\cdot 3894509\\
\log 2 &= 0\cdot 3010300\\
\log r &= 3\cdot 5985800\\
\log \cot u &= 0\cdot 5493377\\
\log u' &= 1\cdot 2278495\\
u' &= 16\cdot 898 \text{ miles}
\end{aligned}$$

$$\begin{aligned}
u_m &= 1091\cdot 662 \text{ miles}\\
u' &= 16\cdot 898 \text{ “}\\
x &= 1108\cdot 560 \text{ “}
\end{aligned}$$

$$\begin{aligned}
\log \sin \alpha &= \bar{2}\cdot 6903504\\
\log r &= 3\cdot 5985800\\
\log \cot u &= 0\cdot 5493377\\
\log y &= 2\cdot 8382681\\
y &= 689\cdot 078 \text{ miles}
\end{aligned}$$

USE OF TABLES FOR A TRANSVERSE POLYCONIC PROJECTION FOR GENERAL MAPS OF CANADA

In Table I will be found meridional distances in statute miles of intersections of parallels with the central meridian for every degree from the origin of co-ordinates, and the logarithms of the radii of the corresponding spherical zones.

Tables II and IIa contain the elements for the computation of rectangular co-ordinates of every fifth degree intersection of parallels and meridians.

Tables III, IV, V, and VI give the co-ordinates in inches of 5-degree quadrilaterals for general maps of Canada, on scales of 1 inch to 50, 60, 80, and 100 statute miles, respectively.

DIRECTIONS FOR PLOTTING THE PROJECTION

(*See* Figure 3)

In the middle of a sheet of paper of determined size according to the scale of the map, draw a vertical line to represent the central meridian of the projection—longitude 95 degrees west—and the axis of ordinates. Midway on this median line, mark the intersection of the parallel of 60 degrees and, through this point as origin of co-ordinates, draw a perpendicular across the sheet to represent the axis of abscissæ. From the origin, scale in the usual manner, the co-ordinates x and y of the intersections of meridians and parallels taken from the tables: abscissæ are plotted on both sides of the central meridian, and the ordinates above or below the axis of abscissæ according to the sign + or − preceding the y values. The plotted intersections are then joined by suitable curves representing meridians and parallels. Should a network of 1-degree quadrilaterals be desired, graticulation may be completed by subdividing the 5-degree quadrilaterals by means of the scale or proportional divider. The parallels should be subdivided in equal parts, and the meridians in the ratio of meridional distances given in Table I.

Table I

Latitude	Number of degrees in arc=n	Meridional distance $=M_{-n}$ or M_n	Log radius of spherical zone=log r	r in statute miles
		Miles		
60° to 40°	20	−1,382·282	3·5976892	3,959·945
60° to 41°	19	−1,313·282	3·5977263	3,960·284
60° to 42°	18	−1,244·270	3·5977646	3,960·633
60° to 43°	17	−1,175·246	3·5978023	3,960·977
60° to 44°	16	−1,106·210	3·5978400	3,961·321
60° to 45°	15	−1,037·162	3·5978777	3,961·665
60° to 46°	14	− 968·102	3·5979152	3,962·006
60° to 47°	13	− 899·029	3·5979525	3,962·346
60° to 48°	12	− 829·944	3·5979901	3,962·690
60° to 49°	11	− 760·847	3·5980272	3,963·028
60° to 50°	10	− 691·738	3·5980642	3,963·366
60° to 51°	9	− 622·617	3·5981012	3,962·704
60° to 52°	8	− 553·484	3·5981377	3,964·037
60° to 53°	7	− 484·339	3·5981740	3,964·368
60° to 54°	6	− 415·182	3·5982099	3,964·695
60° to 55°	5	− 346·018	3·5982450	3,965·016
60° to 56°	4	− 276·833	3·5982802	3,965·337
60° to 57°	3	− 207·642	3·5983165	3,965·669
60° to 58°	2	− 138·439	3·5983511	3,965·985
60° to 59°	1	− 69·225	3·5983856	3,966·300
60° to 60°	0	0·000	3·5984195	3,966·615[1]
60° to 61°	1	+ 69·236	3·5984546	3,966·930
60° to 62°	2	+ 138·482	3·5984859	3,967·218
60° to 63°	3	+ 207·738	3·5985173	3,967·504
60° to 64°	4	+ 277·004	3·5985486	3,967·789
60° to 65°	5	+ 346·280	3·5985800	3,968·075
60° to 66°	6	+ 415·566	3·5986114	3,968·363
60° to 67°	7	+ 484·861	3·5986430	3,968·648
60° to 68°	8	+ 554·165	3·5986716	3,968·913
60° to 69°	9	+ 623·477	3·5987004	3,969·176
60° to 70°	10	+ 692·797	3·5987286	3,969·434
60° to 71°	11	+ 762·125	3·5987562	3,969·686
60° to 72°	12	+ 831·461	3·5987831	3,969·932

[1] This value of r is the length of the meridian radius of curvature of the earth at latitude 60 degrees converted into miles from the Smithsonian Geographical Tables.

Table I—Continued

Latitude	Number of degrees in arc = n	Meridional distance $= M_{-n}$ or M_n	Log radius of spherical zone = log r	r in statute miles
		Miles		Miles
60° to 73°	13	+ 900·805	3·5988101	3,970·179
60° to 74°	14	+ 970·156	3·5988365	3,970·420
60° to 75°	15	+1,039·513	3·5988616	3,970·650
60° to 76°	16	+1,108·876	3·5988854	3,970·867
60° to 77°	17	+1,178·245	3·5989092	3,971·085
60° to 78°	18	+1,247·620	3·5989323	3,971·295
60° to 79°	19	+1,317·000	3·5989547	3,971·501
60° to 80°	20	+1,386·384	3·5989762	3,971·697
60° to 81°	21	+1,455·772	3·5989969	3,971·886
60° to 82°	22	+1,525·164	3·5990163	3,972·065
60° to 85°	25	+1,733·357	3·5990306	3,972·195
60° to 90°	30	+2,080·378	3·5991436	3,973·229

Table II

LATITUDE 40°

λ	$\sin u = \cos\phi \sin\lambda$				$\tan v = \cot\phi \cos\lambda$				$\alpha = \begin{Bmatrix} v-30° \\ 30°-v \end{Bmatrix} \sin u$				
	log sin u	u			log tan v	v			log α (seconds)	α			Sign
°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}$·8245500	3	49	41·56	0·0745307	49	53	32·65	3·6795398	1	19	41·23	—
10	$\bar{1}$·1239242	7	38	39·37	0·0695380	49	34	03·16	3·9717630	2	36	10·50	—
15	$\bar{1}$·2972502	11	26	08·27	0·0611303	49	01	09·00	4·1327442	3	46	15·13	—
20	$\bar{1}$·4183057	15	11	20·13	0·0491723	48	14	12·13	4·2355545	4	46	41·03	—
25	$\bar{1}$·5102023	18	53	22·29	0·0334622	47	12	18·46	4·3021627	5	34	12·23	—
30	$\bar{1}$·5832240	22	31	15·65	0·0137171	45	54	16·87	4·3410516	6	05	30·65	—
35	$\bar{1}$·6428453	26	03	52·74	$\bar{1}$·9895510	44	18	38·90	4·3548119	6	17	16·64	—
40	$\bar{1}$·6923215	29	29	55·35	$\bar{1}$·9604405	42	23	38·72	4·3418386	6	06	10·43	—

LATITUDE 45°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}$·7897810	3	31	59·83	$\bar{1}$·9983442	44	53	26·80	3·5190009	0	55	03·70	—
10	$\bar{1}$·0891552	7	03	10·87	$\bar{1}$·9933515	44	33	41·23	3·8086644	1	47	16·69	—
15	$\bar{1}$·2624812	10	32	43·04	$\bar{1}$·9849438	44	00	25·30	3·9651297	2	33	48·47	—
20	$\bar{1}$·3835367	13	59	43·61	$\bar{1}$·9729858	43	13	09·05	4·0610437	3	11	49·17	—
25	$\bar{1}$·4754333	17	23	15·78	$\bar{1}$·9572757	42	11	10·54	4,1176063	3	38	30·11	—
30	$\bar{1}$·5484550	20	42	17·32	$\bar{1}$·9375306	40	53	36·21	4,1419206	3	51	05·02	—
35	$\bar{1}$·6080763	23	55	38·86	$\bar{1}$·9133645	39	19	21·68	4·1339200	3	46	51·93	—
40	$\bar{1}$·6575525	27	02	02·47	$\bar{1}$·8842540	37	27	13·39	4·0862281	3	23	16·30	—
45	$\bar{1}$·6989700	30	00	00·00	$\bar{1}$·8494850	35	15	51·81	3·9766207	2	37	55·91	—

LATITUDE 50°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}$·7483635	3	12	41·43	$\bar{1}$·9221577	39	53	32·90	3·2999709	0	33	15·13	—
10	$\bar{1}$·0477377	6	24	31·12	$\bar{1}$·9171650	39	34	07·28	3·5848926	1	04	04·97	—
15	$\bar{1}$·2210637	9	34	35·68	$\bar{1}$·9087573	39	01	30·17	3·7328156	1	30	05·25	—
20	$\bar{1}$·3421192	12	42	00·02	$\bar{1}$·8967993	38	15	20·26	3·8151718	1	48	53·89	—
25	$\bar{1}$·4340158	15	45	45·72	$\bar{1}$·8810892	37	15	08·47	3·8507972	1	58	12·45	—
30	$\bar{1}$·5070375	18	44	50·05	$\bar{1}$·8613441	36	00	18·76	3·8418683	1	55	48·13	—
35	$\bar{1}$·5666588	21	38	04·97	$\bar{1}$·8371780	34	30	09·69	3·7764335	1	39	36·31	—
40	$\bar{1}$·6161350	24	24	16·18	$\bar{1}$·8080675	32	43	56·67	3·6089831	1	07	44·27	—
45	$\bar{1}$·6575525	27	02	02·47	$\bar{1}$·9732985	30	40	55·40	3·0476748	0	18	36·03	—
50	$\bar{1}$·6923215	29	29	55·35	$\bar{1}$·7318810	28	20	26·77	3·4685308	0	49	01·24	+

Table II—Continued

LATITUDE 55°

λ	$\sin u = \cos\phi \sin\lambda$				$\tan v = \cot\phi \cos\lambda$				$\alpha = \begin{Bmatrix} v-30° \\ 30°-v \end{Bmatrix} \sin u$				
	log sin u	u			log tan v	v			log α (seconds)	α			Sign
°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot6988873$	2	51	55·57	$\bar{1}\cdot8435710$	34	53	50·76	2·9451583	0	14	41·37	−
10	$\bar{2}\cdot9982615$	5	42	58·19	$\bar{1}\cdot8385783$	34	35	20·31	3·2162797	0	27	25·43	−
15	$\bar{1}\cdot1715875$	8	32	14·13	$\bar{1}\cdot8301706$	34	04	20·64	3·3377405	0	36	16·41	−
20	$\bar{1}\cdot2926430$	11	18	48·08	$\bar{1}\cdot8182126$	33	20	38·80	3·3732262	0	39	21·71	−
25	$\bar{1}\cdot3845393$	14	01	42·47	$\bar{1}\cdot8025025$	32	23	57·68	3·3209364	0	34	53·80	−
30	$\bar{1}\cdot4575613$	16	39	56·77	$\bar{1}\cdot7827574$	31	13	57·07	3·1046576	0	21	12·50	−
35	$\bar{1}\cdot5171826$	19	12	26·93	$\bar{1}\cdot7585913$	29	50	15·25	2·2841528	0	03	12·38	+
40	$\bar{1}\cdot5666588$	21	38	04·97	$\bar{1}\cdot7294808$	28	12	31·21	3·3761374	0	39	37·59	+
45	$\bar{1}\cdot6080763$	23	55	38·86	$\bar{1}\cdot6947118$	26	20	27·60	3·7277412	1	29	02·46	+
50	$\bar{1}\cdot6428453$	26	03	52·74	$\bar{1}\cdot6532943$	24	13	54·42	3·9601894	2	32	04·09	+
55	$\bar{1}\cdot6719558$	28	01	27·55	$\bar{1}\cdot6038181$	21	52	53·43	4·1377337	3	48	52·00	+
60	$\bar{1}\cdot6961219$	29	47	02·42	$\bar{1}\cdot5441968$	19	17	43·23	4·2819972	5	19	02·44	+

LATITUDE 60°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot6392660$	2	29	51·43	$\bar{1}\cdot7597836$	29	54	19·82	1·1709748	0	00	14·82	+
10	$\bar{2}\cdot9386402$	4	58	51·33	$\bar{1}\cdot7547909$	29	37	17·96	2·0728301	0	01	58·26	+
15	$\bar{1}\cdot1119662$	7	26	07·70	$\bar{1}\cdot7463832$	29	08	50·75	2·5989935	0	06	37·19	+
20	$\bar{1}\cdot2330217$	9	50	47·59	$\bar{1}\cdot7344252$	28	28	52·47	2·9708129	0	15	35·00	+
25	$\bar{1}\cdot3249183$	12	11	56·69	$\bar{1}\cdot7187151$	27	37	16·07	3·2575909	0	30	09·63	+
30	$\bar{1}\cdot3979400$	14	28	39·04	$\bar{1}\cdot6989700$	26	33	54·19	3·4901627	0	51	31·45	+
35	$\bar{1}\cdot4575613$	16	39	56·77	$\bar{1}\cdot6748039$	25	18	40·42	3·6849230	1	20	40·86	+
40	$\bar{1}\cdot5070375$	18	44	50·05	$\bar{1}\cdot6456934$	23	51	31·16	3·8516034	1	58	25·64	+
45	$\bar{1}\cdot5484550$	20	42	17·32	$\bar{1}\cdot6109244$	22	12	27·56	3·9964256	2	45	18·03	+
50	$\bar{1}\cdot5832240$	22	31	15·65	$\bar{1}\cdot5695069$	20	21	38·08	4·1235776	3	41	31·61	+
55	$\bar{1}\cdot6123345$	24	10	41·28	$\bar{1}\cdot5200307$	18	19	21·08	4·2359319	4	46	55·99	+
60	$\bar{1}\cdot6365006$	25	39	32·06	$\bar{1}\cdot4604094$	16	06	07·61	4·3357518	6	01	04·65	+
65	$\bar{1}\cdot6562457$	26	56	46·38	$\bar{1}\cdot3873877$	13	42	43·82	4·4244113	7	22	51·21	+
70	$\bar{1}\cdot6719558$	28	01	27·55	$\bar{1}\cdot2954911$	11	10	12·84	4·5031032	8	50	49·54	+
75	$\bar{1}\cdot6839138$	28	52	44·74	$\bar{1}\cdot1744356$	8	29	55·61	4·5726794	10	23	03·45	+

LATITUDE 65°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot5662443$	2	06	37·45	$\bar{1}\cdot6670167$	24	54	59·15	2·8287156	0	11	14·09	+
10	$\bar{2}\cdot8656185$	4	12	30·75	$\bar{1}\cdot6620240$	24	39	56·51	3·1489989	0	23	29·28	+
15	$\bar{1}\cdot0389445$	6	16	46·81	$\bar{1}\cdot6536163$	24	14	51·67	3·3550896	0	37	45·11	+
20	$\bar{1}\cdot1600000$	8	18	39·14	$\bar{1}\cdot6416583$	23	39	44·46	3·5182309	0	54	57·85	+
25	$\bar{1}\cdot2518966$	10	17	18·91	$\bar{1}\cdot6259482$	22	54	35·30	3·6588572	1	15	58·87	+
30	$\bar{1}\cdot3249183$	12	11	56·69	$\bar{1}\cdot6062031$	21	59	25·95	3·7848240	1	41	32·90	+
35	$\bar{1}\cdot3845396$	14	01	42·47	$\bar{1}\cdot5820370$	20	54	20·51	3·8996115	2	12	16·18	+
40	$\bar{1}\cdot4340158$	15	45	45·72	$\bar{1}\cdot5529265$	19	39	26·48	4·0049499	2	48	34·62	+
45	$\bar{1}\cdot4754333$	17	23	15·78	$\bar{1}\cdot5181575$	18	14	56·05	4·1018143	3	30	41·96	+
50	$\bar{1}\cdot5102023$	18	53	22·29	$\bar{1}\cdot4767400$	16	41	07·47	4·1908328	4	18	37·90	+
55	$\bar{1}\cdot5393128$	20	15	12·74	$\bar{1}\cdot4272638$	14	58	26·44	4·2724584	5	12	06·58	+
60	$\bar{1}\cdot5634789$	21	28	08·49	$\bar{1}\cdot3676425$	13	07	27·37	4·3470440	6	10	35·35	+
65	$\bar{1}\cdot5832240$	22	31	15·65	$\bar{1}\cdot2946208$	11	08	54·34	4·4148677	7	13	13·67	+
70	$\bar{1}\cdot5989341$	23	23	56·22	$\bar{1}\cdot2027242$	9	03	41·74	4·4761803	8	18	55·07	+
75	$\bar{1}\cdot6108921$	24	05	34·58	$\bar{1}\cdot0816687$	6	52	54·13	4·5311505	9	26	14·29	+
80	$\bar{1}\cdot6192998$	24	35	41·17	$\bar{2}\cdot9083427$	4	37	45·62	4·5799341	10	33	33·18	+

Table II—Continued

LATITUDE 70°

λ	$\sin u = \cos\phi \sin\lambda$				$\tan v = \cot\phi \cos\lambda$				$\alpha = \begin{cases} v-30° \\ 30°-v \end{cases} \sin u$				
	log sin u	u			log tan v	v			log α (seconds)	α			Sign
°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot4743477$	1	42	29·46	$\bar{1}\cdot5594101$	19	55	47·71	3·0336832	0	18	00·64	+
10	$\bar{2}\cdot7737219$	3	24	17·52	$\bar{1}\cdot5544174$	19	43	11·11	3·3420279	0	36	38·00	+
15	$\bar{2}\cdot9470479$	5	04	42·76	$\bar{1}\cdot5460097$	19	22	12·21	3·5298813	0	56	27·52	+
20	$\bar{1}\cdot0681034$	6	43	03·77	$\bar{1}\cdot5340517$	18	52	54·20	3·6704433	1	18	02·13	+
25	$\bar{1}\cdot1600000$	8	18	39·14	$\bar{1}\cdot5183416$	18	15	22·05	3·7861142	1	41	51·03	+
30	$\bar{1}\cdot2330217$	9	50	47·59	$\bar{1}\cdot4985965$	17	29	42·87	3·8863995	2	08	18·38	+
35	$\bar{1}\cdot2926430$	11	18	48·08	$\bar{1}\cdot4744304$	16	36	06·45	3·9759923	2	37	42·20	+
40	$\bar{1}\cdot3421192$	12	42	00·02	$\bar{1}\cdot4453199$	15	34	45·83	4·0574051	3	10	13·14	+
45	$\bar{1}\cdot3835367$	13	59	43·61	$\bar{1}\cdot4105509$	14	25	57·80	4·1320518	3	45	53·50	+
50	$\bar{1}\cdot4183057$	15	11	20·13	$\bar{1}\cdot3691334$	13	10	04·19	4·2007484	4	24	36·26	+
55	$\bar{1}\cdot4474162$	16	16	12·51	$\bar{1}\cdot3196572$	11	47	31·12	4·2639814	5	06	04·60	+
60	$\bar{1}\cdot4715823$	17	13	45·83	$\bar{1}\cdot2600359$	10	18	50·78	4·3220399	5	49	51·33	+
65	$\bar{1}\cdot4913274$	18	03	27·94	$\bar{1}\cdot1870142$	8	44	41·02	4·3750966	6	35	19·01	+
70	$\bar{1}\cdot5070375$	18	44	50·05	$\bar{1}\cdot0951176$	7	05	45·50	4·4232519	7	21	40·37	+
75	$\bar{1}\cdot5189955$	19	17	27·59	$\bar{2}\cdot9740621$	5	22	53·48	4·4665592	8	07	59·20	+

LATITUDE 75°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot3532922$	1	17	33·23	$\bar{1}\cdot4263967$	14	56	43·74	3·0872615	0	20	22·54	+
10	$\bar{2}\cdot6526664$	2	34	33·38	$\bar{1}\cdot4214040$	14	46	55·80	3·3913217	0	41	02·19	+
15	$\bar{2}\cdot8259924$	3	50	27·47	$\bar{1}\cdot4129963$	14	30	38·95	3·5723234	1	02	15·28	+
20	$\bar{2}\cdot9470479$	5	04	42·76	$\bar{1}\cdot4010383$	14	07	57·81	3·7038528	1	24	16·53	+
25	$\bar{1}\cdot0389445$	6	16	46·81	$\bar{1}\cdot3853282$	13	38	59·05	3·8087719	1	47	18·31	+
30	$\bar{1}\cdot1119662$	7	26	07·70	$\bar{1}\cdot3655831$	13	03	51·61	3·8970715	2	11	29·90	+
35	$\bar{1}\cdot1715875$	8	32	14·12	$\bar{1}\cdot3414170$	12	22	46·58	3·9739057	2	36	56·85	+
40	$\bar{1}\cdot2210637$	9	34	35·68	$\bar{1}\cdot3123065$	11	35	58·46	4·0421964	3	03	40·32	+
45	$\bar{1}\cdot2624812$	10	32	43·04	$\bar{1}\cdot2775375$	10	43	42·90	4·1037036	3	31	37·07	+
50	$\bar{1}\cdot2972502$	11	26	08·27	$\bar{1}\cdot2361200$	9	46	20·76	4·1594963	4	00	37·63	+
55	$\bar{1}\cdot3263607$	12	14	25·05	$\bar{1}\cdot1866448$	8	44	14·66	4·2102794	4	30	28·54	+
60	$\bar{1}\cdot3505268$	12	57	09·13	$\bar{1}\cdot1270225$	7	37	50·67	4·2564809	5	00	50·57	+
65	$\bar{1}\cdot3702719$	13	33	58·53	$\bar{1}\cdot0540008$	6	27	38·39	4·2983686	5	31	17·81	+
70	$\bar{1}\cdot3859820$	14	04	35·13	$\bar{2}\cdot9621042$	5	14	10·29	4·3361020	6	01	22·13	+

LATITUDE 80°

°		°	′	″		°	′	″		°	′	″	
5	$\bar{2}\cdot1799662$	0	52	01·82	$\bar{1}\cdot2446630$	9	57	45·76	3·0381076	0	18	11·71	+
10	$\bar{2}\cdot4793404$	1	43	40·59	$\bar{1}\cdot2396703$	9	51	03·89	3·3398947	0	36	27·23	+
15	$\bar{2}\cdot6526664$	2	34	33·38	$\bar{1}\cdot2312626$	9	39	56·87	3·5171961	0	54	50·00	+
20	$\bar{2}\cdot7737219$	3	24	17·52	$\bar{1}\cdot2193046$	9	24	28·96	3·6437220	1	13	22·73	+
25	$\bar{2}\cdot8656185$	4	12	30·75	$\bar{1}\cdot2035945$	9	04	46·08	3·7424894	1	32	07·00	+
30	$\bar{2}\cdot9386402$	4	58	51·33	$\bar{1}\cdot1838494$	8	40	55·93	3·8236850	1	51	03·23	+
35	$\bar{2}\cdot9982615$	5	42	58·19	$\bar{1}\cdot1596833$	8	13	07·98	3·8926441	2	10	09·88	+
40	$\bar{1}\cdot0477377$	6	24	31·12	$\bar{1}\cdot1305728$	7	41	33·47	3·9524886	2	29	23·73	+
45	$\bar{1}\cdot0891552$	7	03	10·87	$\bar{1}\cdot0958038$	7	06	25·48	4·0051590	2	48	39·50	+
50	$\bar{1}\cdot1239242$	7	38	39·37	$\bar{1}\cdot0543863$	6	27	58·88	4·0519159	3	07	49·77	+
55	$\bar{1}\cdot1530347$	8	10	39·83	$\bar{1}\cdot0049101$	5	46	30·32	4·0935994	3	26	45·07	+
60	$\bar{1}\cdot1772008$	8	38	56·99	$\bar{2}\cdot9452888$	5	02	18·13	4·1307761	3	45	13·76	+

Table IIa

LATITUDE 40°

λ	log sin α	log (2 sin² α/2)	log (r cot u)	u_m	u′	x	y
°				Miles	Miles	Miles	Miles
5	$\bar{2}\cdot3650756$	$\bar{4}\cdot4291778$	4·7721699	264·583	15·898	280·482	−1,371·657
10	$\bar{2}\cdot6571883$	$\bar{3}\cdot0135706$	4·4698885	528·326	30·441	558·767	−1,339·913
15	$\bar{2}\cdot8180053$	$\bar{3}\cdot3354502$	4·2917307	790·363	42·382	832·745	−1,287·467
20	$\bar{2}\cdot9206261$	$\bar{3}\cdot5409802$	4·1639411	1,049·768	50·690	1,100·458	−1,214·973
25	$\bar{2}\cdot9870525$	$\bar{3}\cdot6740938$	4·0634444	1,305·532	54·644	1,360·176	−1,123·302
30	$\bar{1}\cdot0258074$	$\bar{3}\cdot7526318$	3·9800146	1,557·368	54·031	1,611·399	−1,013·493
35	$\bar{1}\cdot0395144$	$\bar{3}\cdot7793078$	3·9082645	1,801·435	48·705	1,850·140	− 886·704
40	$\bar{1}\cdot0265917$	$\bar{3}\cdot7533860$	3·8450701	2,038·777	39·669	2,078·446	− 744·152

LATITUDE 45°

				Miles	Miles	Miles	Miles
5	$\bar{2}\cdot2045569$	$\bar{4}\cdot1081093$	4·8072705	244·306	8·229	252·535	−1,027·608
10	$\bar{2}\cdot4941670$	$\bar{4}\cdot6874096$	4·5054240	487·676	15·589	503·265	− 999·059
15	$\bar{2}\cdot6505596$	3·0003056	4·3279990	729·145	21·296	750·441	− 951·828
20	$\bar{2}\cdot7463935$	$\bar{3}\cdot1920942$	4·2012537	967·703	24·737	992·440	− 886·436
25	$\bar{2}\cdot8028887$	$\bar{3}\cdot3051862$	4·1021314	1,202·258	25·545	1,227·803	− 803·563
30	$\bar{2}\cdot8271682$	$\bar{3}\cdot3537985$	4·0204268	1,431·615	23·672	1,455·287	− 704·036
35	$\bar{2}\cdot8191793$	$\bar{3}\cdot3378009$	3·9507760	1,654·443	19·434	1,673·877	− 588·783
40	$\bar{2}\cdot7715499$	$\bar{3}\cdot2424492$	3·8900747	1,869·242	13·568	1,882·810	− 458·801
45	$\bar{2}\cdot6620425$	$\bar{3}\cdot0232851$	3·8364383	2,074·323	7·240	2,081·563	− 315·123

LATITUDE 50°

				Miles	Miles	Miles	Miles
5	$\bar{3}\cdot9855393$	$\bar{5}\cdot6700542$	4·8490239	222·152	3·305	225·457	− 683·224
10	$\bar{2}\cdot2704427$	$\bar{4}\cdot2398908$	4·5476046	443·310	6·131	449·441	− 657·730
15	$\bar{2}\cdot4183410$	$\bar{4}\cdot5357248$	4·3709058	662·448	8·066	670·514	− 615·526
20	$\bar{2}\cdot5006741$	$\bar{4}\cdot7004256$	4·2451877	878·315	8·822	887·137	− 557·009
25	$\bar{2}\cdot5362855$	$\bar{4}\cdot7715683$	4·1474019	1,090·366	8·298	1,098·664	− 482·711
30	$\bar{2}\cdot5273606$	$\bar{4}\cdot7538132$	4·0673518	1,296·817	6·625	1,303·442	− 393·289
35	$\bar{2}\cdot4619472$	$\bar{4}\cdot6229542$	3·9996797	1,496·555	4·194	1,500·749	− 289·486
40	$\bar{2}\cdot2945293$	$\bar{4}\cdot2880706$	3·9412814	1,688·190	1·696	1,689·886	− 172·112
45	$\bar{3}\cdot7332486$	$\bar{5}\cdot1654636$	3·8902612	1,870·045	0·114	1,870·159	− 42·025
50	$\bar{2}\cdot1540906$	$\bar{4}\cdot0071733$	3·8454451	2,040·537	0·712	2,041·249	+ 99·893

LATITUDE 55°

°				Miles	Miles	Miles	Miles
5	$\bar{3}\cdot6307318$	$\bar{6}\cdot9604252$	4·8988151	198·296	0·723	199·019	− 338·491
10	$\bar{3}\cdot9018497$	$\bar{5}\cdot5026708$	4·5978188	395·573	1·260	396·834	− 315·987
15	$\bar{2}\cdot0233075$	$\bar{5}\cdot7455930$	4·4218185	590·804	1·470	592·274	− 278·693
20	$\bar{2}\cdot0587920$	$\bar{5}\cdot8165645$	4·2970801	782·916	1·299	784·215	− 226·920
25	$\bar{2}\cdot0065026$	$\bar{5}\cdot7119864$	4·2005557	970·806	0·818	971·624	− 161·086
30	$\bar{3}\cdot7902298$	$\bar{5}\cdot2794338$	4·1220465	1,153·314	0·252	1,153·566	− 81·710
35	$\bar{4}\cdot9697333$	$\bar{7}\cdot6383434$	4·0561878	1,329·208	0·005	1,329·213	+ 10·615
40	$\bar{2}\cdot0617022$	$\bar{5}\cdot8223924$	3·9998605	1,497·178	0·664	1,497·842	+ 115·229
45	$\bar{2}\cdot4132676$	$\bar{4}\cdot5255780$	3·9511433	1,655·842	2·997	1,658·839	+ 231·425
50	$\bar{2}\cdot6456230$	$\bar{4}\cdot9904280$	3·9088203	1,803·762	7·930	1,811·692	+ 358·462
55	$\bar{2}\cdot8229878$	3·3454270	3·8721260	1,939·355	16·503	1,955·858	+ 495·580
60	$\bar{2}\cdot9669486$	$\bar{3}\cdot6338026$	3·8405949	2,061·131	29·812	2,090·943	+ 642·012

Table IIa—Continued

LATITUDE 60°

λ	log sin α	log (2 sin² α/2)	log (r cot u)	u_m	u′	x	y
°				Miles	Miles	Miles	Miles
5	$\bar{5}$·8562727	$\bar{9}$·4099292	4·9587418	172·911	0·000	172·911	+ 6·532
10	$\bar{4}$·7583731	$\bar{7}$·2155216	4·6581364	344·832	0·007	344·839	+ 26·092
15	$\bar{3}$·2845727	$\bar{6}$·2678948	4·4827861	514·773	0·056	514·829	+ 58·527
20	$\bar{3}$·6563850	$\bar{5}$·0117417	4·3589528	681·681	0·235	681·916	+ 103·595
25	$\bar{3}$·9431603	$\bar{5}$·5852918	4·2635772	844·548	0·706	845·254	+ 160·967
30	$\bar{2}$·1757208	$\bar{4}$·0504360	4·1864652	1,002·284	1·725	1,004·009	+ 230·243
35	$\bar{2}$·3704575	$\bar{4}$·4399448	4·1222210	1,153·787	3·649	1,157·436	+ 310·941
40	$\bar{2}$·5370922	$\bar{4}$·7732832	4·0677071	1,297·879	6·934	1,304·813	+ 402·531
45	$\bar{2}$·6818329	$\bar{3}$·0628868	4·0209686	1,433·402	12·130	1,445·532	+ 504·431
50	$\bar{2}$·8088518	$\bar{3}$·3171246	3·9807448	1,559·139	19·628	1,578·767	+ 616·023
55	$\bar{2}$·9210027	$\bar{3}$·5417310	3·9462137	1,673·785	30·757	1,704·542	+ 736·574
60	$\bar{1}$·0205277	$\bar{3}$·7412254	3·9168306	1,776·399	45·505	1,821·904	+ 865·682
65	$\bar{1}$·1087844	$\bar{3}$·9183418	3·8922621	1,865·497	64·655	1,930·152	+1,002·413
70	$\bar{1}$·1869509	$\bar{2}$·0754630	3·8723005	1,940·135	88·667	2,028·802	+1,146·175
75	$\bar{1}$·2558741	$\bar{2}$·2142895	3·8568317	1,999·357	117·793	2,117·150	+1,296·301

LATITUDE 65°

°				Miles	Miles	Miles	Miles
5	$\bar{3}$·5142920	$\bar{6}$·7275550	5·0321440	146·158	0·575	146·733	+ 351·914
10	$\bar{3}$·8345688	$\bar{5}$·3681124	4·7317898	291·582	1·259	292·841	+ 368·433
15	$\bar{2}$·0406554	$\bar{5}$·7802938	4·5570222	434·905	2·174	437·079	+ 395·984
20	$\bar{2}$·2037872	$\bar{4}$·1066000	4·4339953	575·578	3·553	579·131	+ 434·193
25	$\bar{2}$·3443967	$\bar{4}$·3878165	4·3396436	712·546	5·339	717·885	+ 483·104
30	$\bar{2}$·4703358	$\bar{4}$·6397362	4·2637427	844·859	8·007	852·866	+ 542·099
35	$\bar{2}$·5850792	$\bar{4}$·8692891	4·2008907	971·555	11·754	983·309	+ 610·900
40	$\bar{2}$·6903504	$\bar{3}$·0799318	4·1479177	1,091·662	16·899	1,108·561	+ 689·078
45	$\bar{2}$·7871173	$\bar{3}$·2736126	4·1028337	1,204·204	23·793	1,227·997	+ 776·160
50	$\bar{2}$·8759980	$\bar{3}$·4515808	4·0643352	1,308·213	32·803	1,341·016	+ 871·632
55	$\bar{2}$·9574355	$\bar{3}$·6147383	4·0315658	1,402·679	44·290	1,446·969	+ 974·993
60	$\bar{1}$·0317775	$\bar{3}$·7637870	4·0038714	1,486·858	58·568	1,545·426	+1,085·548
65	$\bar{1}$·0992923	$\bar{3}$·8992968	3·9809053	1,559·715	75·893	1,635·608	+1,202·812
70	$\bar{1}$·1602295	$\bar{2}$·0232227	3·9623761	1,620·514	96·738	1,717·252	+1,326·189
75	$\bar{1}$·2147598	$\bar{2}$·1314384	3·9481037	1,668·581	120·098	1,788·679	+1,455·002
80	$\bar{1}$·2630479	$\bar{2}$·2287587	3·9379751	1,702·943	146·803	1,849·746	+1,588·631

LATITUDE 70°

°				Miles	Miles	Miles	Miles
5	$\bar{3}$·7192439	$\bar{5}$·1374804	5·1241932	118·342	1·827	120·169	+ 697·328
10	$\bar{2}$·0275943	$\bar{5}$·7541710	4·8242405	235·888	3·788	239·676	+ 710·943
15	$\bar{2}$·2154372	$\bar{4}$·1298736	4·6499730	351·840	6·024	357·864	+ 733·517
20	$\bar{2}$·3559811	$\bar{4}$·4109881	4·5276333	465·401	8·682	474·083	+ 764·917
25	$\bar{2}$·4716257	$\bar{4}$·6423168	4·4341439	575·775	11·925	587·700	+ 804·951
30	$\bar{2}$·5718734	$\bar{4}$·8428681	4·3592619	682·166	15·927	698·093	+ 853·366
35	$\bar{2}$·6614055	$\bar{3}$·0220277	4·2975637	783·786	20·873	804·659	+ 909·851
40	$\bar{2}$·7427584	$\bar{3}$·1848191	4·2458521	879·853	26·957	906·810	+ 974·115
45	$\bar{2}$·8173138	$\bar{3}$·3340664	4·2021046	969·602	34·369	1,003·971	+1,045·727
50	$\bar{2}$·8858942	$\bar{3}$·4714018	4·1649805	1,052·282	43·289	1,095·571	+1,124·280
55	$\bar{2}$·9489824	$\bar{3}$·5977958	4·1335617	1,127·191	53·871	1,181·062	+1,209·328
60	$\bar{1}$·0068649	$\bar{3}$·7138247	4·1072072	1,193·647	66·227	1,259·874	+1,300·386
65	$\bar{1}$·0597138	$\bar{3}$·8198341	4·0854649	1,251·036	80·409	1,331·445	+1,396·943
70	$\bar{1}$·1076313	$\bar{3}$·9160261	4·0680162	1,298·803	96·292	1,395·095	+1,498·468
75	$\bar{1}$·1506746	$\bar{2}$·0025087	4·0546275	1,336·475	114·060	1,450·535	+1,604·361

Table IIa—Continued

LATITUDE 75°

λ	log sin α	log (2 sin² α/2)	log (r cot u)	u_m	u′	x	y
°				Miles	Miles	Miles	Miles
5	$\bar{3}\cdot7728354$	$\bar{5}\cdot2446443$	5·2454674	89·576	3·091	92·667	+ 1,043·044
10	$\bar{2}\cdot0768861$	$\bar{5}\cdot8527576$	4·9957582	178·515	6·288	184·803	+ 1,053·524
15	$\bar{2}\cdot2578742$	$\bar{4}\cdot2147542$	4·7718938	266·182	9·697	275·880	+ 1,070·947
20	$\bar{2}\cdot3893839$	$\bar{4}\cdot4778032$	4·6501060	351·148	13·425	364·573	+ 1,095·191
25	$\bar{2}\cdot4942762$	$\bar{4}\cdot6876282$	4·5573038	435·187	17·577	452·764	+ 1,126·108
30	$\bar{2}\cdot5825405$	$\bar{4}\cdot8642118$	4·4832282	515·285	22·256	537·541	+ 1,163·506
35	$\bar{2}\cdot6593297$	$\bar{3}\cdot0178556$	4·4224351	591·640	27·560	619·200	+ 1,207·160
40	$\bar{2}\cdot7275511$	$\bar{3}\cdot1544052$	4·3717032	663·666	33·582	697·248	+ 1,256·765
45	$\bar{2}\cdot7890041$	$\bar{3}\cdot2773896$	4·3289829	730·798	40·399	771·197	+ 1,312·130
50	$\bar{2}\cdot8447161$	$\bar{3}\cdot3889353$	4·2929031	792·500	48·067	840·567	+ 1,372·837
55	$\bar{2}\cdot8954061$	$\bar{3}\cdot4904548$	4·2625144	848·264	56·620	904·884	+ 1,438·535
60	$\bar{2}\cdot9415113$	$\bar{3}\cdot5828244$	4·2371417	897·623	66·064	963·687	+ 1,508·874
65	$\bar{2}\cdot9832710$	$\bar{3}\cdot6665207$	4·2163004	940·154	76·352	1,016·506	+ 1,583·330
70	$\bar{1}\cdot0208767$	$\bar{3}\cdot7419236$	4·1996289	975·510	87·408	1,062·918	+ 1,661·520

LATITUDE 80°

°				Miles	Miles	Miles	Miles
5	$\bar{3}\cdot7236801$	$\bar{5}\cdot1459351$	5·4189626	60·113	3·672	63·785	+ 1,388·810
10	$\bar{2}\cdot0254612$	$\bar{5}\cdot7499045$	5·1194425	119·777	7·402	127·179	+ 1,396·059
15	$\bar{2}\cdot2027523$	$\bar{4}\cdot1045024$	4·9458728	178·561	11·230	189·791	+ 1,408·073
20	$\bar{2}\cdot3292640$	$\bar{4}\cdot3575473$	4·8244881	236·023	15·206	251·229	+ 1,424·781
25	$\bar{2}\cdot4280124$	$\bar{4}\cdot5550805$	4·7321860	291·733	19·376	311·109	+ 1,446·100
30	$\bar{2}\cdot5091841$	$\bar{4}\cdot7174516$	4·6586931	345·274	23·776	369·050	+ 1,471·896
35	$\bar{2}\cdot5781154$	$\bar{4}\cdot8553566$	4·5985500	396·240	28·439	424·679	+ 1,501·985
40	$\bar{2}\cdot6379269$	$\bar{4}\cdot9750288$	4·5485166	444·242	33·485	477·727	+ 1,536·185
45	$\bar{2}\cdot6905597$	$\bar{3}\cdot0803505$	4·5065225	488·910	38·625	527·535	+ 1,574·280
50	$\bar{2}\cdot7372738$	$\bar{3}\cdot1738418$	4·4711755	529·894	44·159	574·053	+ 1,616·029
55	$\bar{2}\cdot7789123$	$\bar{3}\cdot2571873$	4·4415031	566·868	49·968	616·836	+ 1,661·175
60	$\bar{2}\cdot8160403$	$\bar{3}\cdot3315168$	4·4168086	599·553	56·018	655·571	+ 1,709·420

Table III. Co-ordinates for a Transverse Polyconic Projection of Map of Canada

(Scale, 1 inch to 50 statute miles)

Longitude from central meridian	Latitude 40°		Latitude 45°		Latitude 50°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	−27·646	0·000	−20·743	0·000	−13·835
5	5·610	−27·433	5·051	−20·552	4·509	−13·664
10	11·175	−26·798	10·065	−19·981	8·988	−13·155
15	16·655	−25·749	15·009	−19·037	13·410	−12·311
20	22·009	−24·299	19·849	−17·729	17·743	−11·140
25	27·203	−22·466	24·556	−16·071	21·973	− 9·654
30	32·228	−20·270	29·106	−14·081	26·069	− 7·866
35	37·003	−17·734	33·478	−11·757	30·015	− 5·790
40	41·569	−14·883	37·656	− 9·176	33·798	− 3·442
45	.....	.....	41·631	− 6·302	37·403	− 0·840
50	.....	.....	.....	.....	40·825	+ 1·998

Table III. Co-ordinates for a Transverse Polyconic Projection of Map of Canada—Continued

(Scale, 1 inch to 50 statute miles)

Longitude from central meridian	Latitude 55°		Latitude 60°		Latitude 65°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	− 6·920	0·000	0·000	0·000	+ 6·926
5	3·980	− 6·790	3·458	+ 0·131	2·935	+ 7·038
10	7·937	− 6·320	6·897	+ 0·522	5·857	+ 7·369
15	11·845	− 5·574	10·297	+ 1·170	8·742	+ 7·920
20	15·684	− 4·538	13·638	+ 2·072	11·583	+ 8·684
25	19·432	− 3·222	16·905	+ 3·219	14·358	+ 9·662
30	23·071	− 1·634	20·080	+ 4·605	17·057	+10·842
35	26·584	+ 0·212	23·149	+ 6·219	19·666	+12·218
40	29·957	+ 2·304	26·096	+ 8·051	22·171	+13·782
45	33·177	+ 4·628	28·911	+10·089	24·560	+15·523
50	36·234	+ 7·169	31·575	+12·320	26·820	+17·433
55	39·117	+ 9·912	34·091	+14·731	28·939	+19·500
60	41·819	+12·840	36·438	+17·313	30·909	+21·711
65	.....	.....	38·603	+20·048	32·712	+24·056
70	.....	.....	40·576	+22·924	34·345	+26·524
75	.....	.....	42·343	+25·926	35·774	+29·100
80	.....	.....	.....	.....	36·995	+31·773

Longitude from central meridian	Latitude 70°		Latitude 75°		Latitude 80°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	+13·856	0·000	+20·790	0·000	+27·728
5	2·403	+13·947	1·853	+20·861	1·276	+27·776
10	4·793	+14·219	3·696	+21·070	2·544	+27·921
15	7·157	+14·670	5·518	+21·419	3·796	+28·161
20	9·482	+15·298	7·291	+21·904	5·025	+28·496
25	11·754	+16·099	9·055	+22·522	6·222	+28·922
30	13·962	+17·067	10·751	+23·270	7·381	+29·438
35	16·093	+18·177	12·384	+24·143	8·494	+30·040
40	18·136	+19·482	13·945	+25·135	9·555	+30·724
45	20·079	+20·915	15·424	+26·243	10·551	+31·486
50	21·911	+22·486	16·811	+27·457	11·481	+32·521
55	23·621	+24·187	18·100	+28·771	12·337	+33·224
60	25·197	+26·008	19·274	+30·178	13·111	+34·188
65	26·629	+27·939	20·330	+31·667		
70	27·902	+29·969	21·258	+33·230		
75	29·011	+32·087				

Table IV. Co-ordinates for a Transverse Polyconic Projection of Map of Canada

(Scale, 1 inch to 60 statute miles)

Longitude from central meridian	Latitude 40°		Latitude 45°		Latitude 50°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	−23·038	0·000	−17·286	0·000	−11·529
5	4·675	−22·861	4·209	−17·127	3·758	−11·387
10	9·313	−22·332	8·388	−16·651	7·491	−10·962
15	13·879	−21·458	12·507	−15·864	11·175	−10·259
20	18·341	−20·250	16·541	−14·774	14·786	− 9·283
25	22·670	−18·722	20·463	−13·393	18·311	− 8·045
30	26·857	−16·892	24·255	−11·734	21·724	− 6·555
35	30·836	−14·778	27·898	− 9·813	25·012	− 4·825
40	34·641	−12·403	31·380	− 7·647	28·165	− 2·869
45	.....	.....	34·673	− 5·252	31·169	− 0·700
50	.....	.....	.....	.....	34·021	+ 1·665

Longitude from central meridian	Latitude 55°		Latitude 60°		Latitude 65°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	− 5·767	0·000	0·000	0·000	+ 5·771
5	3·317	− 5·642	2·882	+ 0·109	2·446	+ 5·865
10	6·614	− 5·266	5·747	+ 0·435	4·881	+ 6·141
15	9·705	− 4·645	8·581	+ 0·976	7·285	+ 6·600
20	13·070	− 3·782	11·365	+ 1·727	9·652	+ 7·237
25	16·194	− 2·685	14·088	+ 2·682	11·965	+ 8·052
30	19·226	− 1·362	16·733	+ 3·837	14·214	+ 9·035
35	22·154	+ 0·177	19·291	+ 5·182	16·388	+10·182
40	24·964	+ 1·920	21·747	+ 6·709	18·093	+11·485
45	27·647	+ 3·857	24·092	+ 8·407	20·467	+12·936
50	30·195	+ 5·974	26·313	+10·267	22·350	+14·527
55	32·598	+ 8·260	28·409	+12·276	24·116	+16·250
60	34·849	+10·700	30·365	+14·418	25·757	+18·092
65	.....	.....	32·169	+16·707	27·260	+20·047
70	.....	.....	33·813	+19·105	28·621	+22·103
75	.....	.....	35·286	+21·605	29·811	+24·250
80	.....	.....	.....	.....	30·829	+26·477

Longitude from central meridian	Latitude 70°		Latitude 75°		Latitude 80°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	+11·547	0·000	+17·325	0·000	+23·106
5	2·003	+11·622	1·544	+17·384	1·063	+23·147
10	3·995	+11·849	3·080	+17·559	2·120	+23·268
15	5·964	+12·225	4·598	+17·849	3·163	+23·468
20	7·901	+12·749	6·076	+18·253	4·187	+23·746
25	9·795	+13·416	7·546	+18·768	5·185	+24·102
30	11·635	+14·223	8·959	+19·392	6·151	+24·532
35	13·411	+15·164	10·320	+20·119	7·078	+25·033
40	15·113	+16·235	11·621	+20·946	7·962	+25·603
45	16·733	+17·429	12·853	+21·869	8·792	+26·238
50	18·260	+18·738	14·009	+22·881	9·568	+26·934
55	19·684	+20·155	15·081	+23·976	10·281	+27·686
60	20·998	+21·673	16·061	+25·148	10·926	+28·490
65	22·191	+23·282	16·942	+26·389		
70	23·251	+24·974	17·715	+27·692		
75	24·176	+26·739				

Table V. Co-ordinates for a Transverse Polyconic Projection for Map of Canada

(Scale, 1 inch to 80 statute miles)

Longitude from central meridian	Latitude 40°		Latitude 45°		Latitude 50°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	−17·279	0·000	−12·965	0·000	−8·647
5	3·506	−17·146	3·157	−12·845	2·818	−8·540
10	6·985	−16·749	6·291	−12·488	5·618	−8·222
15	10·409	−16·093	9·381	−11·898	8·381	−7·694
20	13·756	−15·187	12·405	−11·081	11·089	−6·963
25	17·002	−14·041	15·347	−10·045	13·733	−6·034
30	20·142	−12·669	18·191	− 8·800	16·293	−4·916
35	23·127	−11·084	20·923	− 7·360	18·759	−3·619
40	25·981	− 9·302	23·535	− 5·735	21·124	−2·151
45			26·020	− 3·939	23·377	−0·503
50					25·516	+1·249

Longitude from central meridian	Latitude 55°		Latitude 60°		Latitude 65°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	−4·327	0·000	0·000	0·000	+ 4·329
5	2·488	−4·231	2·161	+ 0·082	1·834	+ 4·399
10	4·960	−3·950	4·310	+ 0·326	3·661	+ 4·605
15	7·403	−3·484	6·435	+ 0·732	5·463	+ 4·950
20	9·803	−2·836	8·524	+ 1·295	7·239	+ 5·427
25	12·145	−2·014	10·566	+ 2·011	8·974	+ 6·039
30	14·420	−1·021	12·550	+ 2·878	10·661	+ 6·776
35	16·615	+0·133	14·468	+ 3·886	12·291	+ 7·636
40	18·723	+1·440	16·310	+ 5·032	13·857	+ 8·614
45	20·735	+2·893	18·069	+ 6·305	15·350	+ 9·702
50	22·646	+4·481	19·735	+ 7·700	16·763	+10·895
55	24·448	+6·195	21·307	+ 9·207	18·087	+12·187
60	26·137	+8·025	22·774	+10·821	19·318	+13·569
65			24·127	+12·530	20·445	+15·035
70			25·360	+14·327	21·466	+16·577
75			26·464	+16·204	22·358	+18·188
80					23·122	+19·858

Longitude from central meridian	Latitude 70°		Latitude 75°		Latitude 80°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	+ 8·660	0·000	+12·994	0·000	+17·330
5	1·502	+ 8·717	1·158	+13·038	0·797	+17·360
10	2·986	+ 8·887	2·310	+13·169	1·590	+17·451
15	4·473	+ 9·169	3·448	+13·357	2·372	+17·601
20	5·826	+ 9·561	4·557	+13·690	3·140	+17·810
25	7·346	+10·062	5·660	+14·076	3·889	+18·076
30	8·726	+10·667	6·719	+14·544	4·613	+18·399
35	10·058	+11·373	7·740	+15·090	5·308	+18·775
40	11·335	+12·176	8·716	+15·710	5·972	+19·202
45	12·550	+13·072	9·640	+16·402	6·594	+19·679
50	13·965	+14·054	10·507	+17·160	7·176	+20·200
55	14·763	+15·117	11·311	+17·982	7·710	+20·765
60	15·748	+16·255	12·046	+18·861	8·195	+21·368
65	16·643	+17·462	12·706	+19·792		
70	17·438	+18·731	13·286	+20·769		
75	18·132	+20·055				

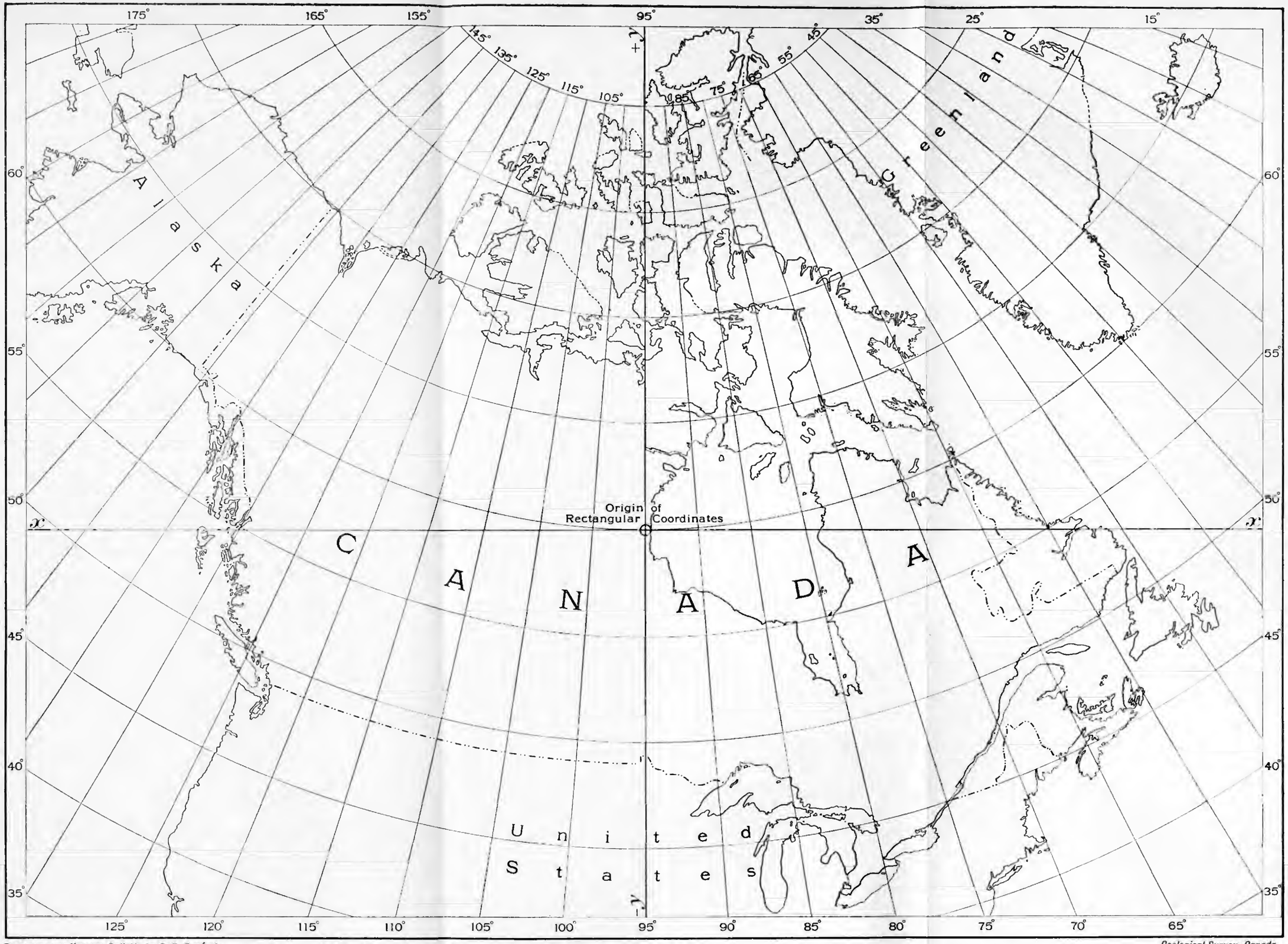
Table VI. Co-ordinates for a Transverse Polyconic Projection of Map of Canada

(Scale, 1 inch to 100 statute miles)

Longitude from central meridian	Latitude 40°		Latitude 45°		Latitude 50°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	−13·823	0·000	−10·372	0·000	− 6·917
5	2·805	−13·717	2·525	−10·276	2·255	− 6·832
10	5·588	−13·399	5·033	− 9·991	4·494	− 6·577
15	8·327	−12·875	7·504	− 9·518	6·705	− 6·155
20	11·005	−12·150	9·924	− 8·864	8·871	− 5·570
25	13·602	−11·233	12·278	− 8·036	10·987	− 4·827
30	16·114	−10·135	14·553	− 7·040	13·034	− 3·933
35	18·501	− 8·867	16·739	− 5·888	15·007	− 2·895
40	20·784	− 7·442	18·828	− 4·588	16·899	− 1·721
45	.....	.....	20·816	− 3·151	18·702	− 0·420
50	.....	.....	.....	.....	20·412	+ 0·999

Longitude from central meridian	Latitude 55°		Latitude 60°		Latitude 65°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	− 3·460	0·000	0·000	0·000	+ 3·463
5	1·990	− 3·385	1·729	+ 0·065	1·467	+ 3·519
10	3·968	− 3·160	3·448	+ 0·261	2·928	+ 3·684
15	5·923	− 2·787	5·148	+ 0·585	4·371	+ 3·960
20	7·842	− 2·269	6·819	+ 1·036	5·791	+ 4·342
25	9·716	− 1·611	8·453	+ 1·610	7·179	+ 4·831
30	11·536	− 0·817	10·040	+ 2·302	8·529	+ 5·421
35	13·292	+ 0·106	11·574	+ 3·109	9·833	+ 6·109
40	14·978	+ 1·152	13·048	+ 4·025	11·086	+ 6·891
45	16·588	+ 2·314	14·455	+ 5·044	12·280	+ 7·762
50	18·117	+ 3·585	15·788	+ 6·160	13·410	+ 8·716
55	19·559	+ 4·956	17·045	+ 7·366	14·470	+ 9·750
60	20·909	+ 6·420	18·219	+ 8·657	15·454	+10·855
65	.....	.....	19·302	+10·024	16·356	+12·028
70	.....	.....	20·288	+11·462	17·173	+13·262
75	.....	.....	21·172	+12·963	17·887	+14·550
80	.....	.....	.....	.....	18·497	+15·886

Longitude from central meridian	Latitude 70°		Latitude 75°		Latitude 80°	
	x	y	x	y	x	y
°	Inches	Inches	Inches	Inches	Inches	Inches
0	0·000	+ 6·928	0·000	+10·395	0·000	+13·864
5	1·202	+ 6·973	0·927	+10·430	0·638	+13·888
10	2·397	+ 7·109	1·848	+10·535	1·272	+13·961
15	3·579	+ 7·335	2·759	+10·709	1·898	+14·081
20	4·741	+ 7·649	3·646	+10·952	2·512	+14·248
25	5·877	+ 8·050	4·528	+11·261	3·111	+14·461
30	6·981	+ 8·534	5·375	+11·635	3·691	+14·719
35	8·047	+ 9·099	6·192	+12·072	4·247	+15·020
40	9·068	+ 9·741	6·972	+12·568	4·777	+15·362
45	10·040	+10·457	7·712	+13·121	5·275	+15·743
50	10·956	+11·243	8·406	+13·728	5·741	+16·160
55	11·811	+12·093	9·049	+14·385	6·168	+16·612
60	12·599	+13·004	9·637	+15·089	6·556	+17·094
65	13·314	+13·969	10·165	+15·833		
70	13·950	+14·985	10·629	+16·615		
75	14·505	+16·044				



To accompany Museum Bulletin by C.-O. Senécal.

Geological Survey, Canada.

Figure 3.

Transverse Polyconic Projection for map of Canada

Scale. $\frac{1}{25,344,000}$ or 1 Inch to 400 Miles

Miles: 400 200 0 400 800

Kilometres: 500 0 500 1000