CLOSED TRAVERSE COMPUTATIONS

GENERAL PROCEDURE

1. CALCULATE THE INTERIOR ANGLES USING THE DATA COLLECTED IN THE FIELD
2. CHECK FOR ANGULAR ERROR, COMPARE TO THE ALLOWABLE ERROR CRITERION AND CORRECT THE ANGLES
3. COMPUTE THE BEARINGS OF THE LINES USING THE CORRECTED ANGLES
4. CALCULATE THE LATITUDE AND DEPARTURE OF EVERY LINE ON THE TRAVERSE
5. CALCULATE THE ERROR OF CLOSURE AND COMPARE TO THE DESIRED PRECISION OF THE TRAVERSE
6. CORRECT THE ERROR BY BALANCING LATITUDES AND DEPARTURES THROUGH THE ADJUSTMENT OF THE LATITUDE AND DEPARTURE OF EVERY LINE OF THE TRAVERSE
7. CALCULATE THE TOTAL LATITUDE AND TOTAL DEPARTURE OF EVERY POINT AND PLOT THE TRAVERSE
8. RECALCULATE BEARINGS AND DISTANCES FOR ALL LINES

CALCULATE THE INTERIOR ANGLES USING THE DATA COLLECTED IN THE FIELD

DIRECTIONAL DATA

B.S. AND F.S. AT EACH POINT

CALCULATE THE ANGLE BETWEEN THE TWO LINES WHICH IS INTERIOR TO THE TRAVERSE

ANGULAR DATA

INTERIOR ANGLE MEASURED

NO CALCULATION REQUIRED

EXTERIOR ANGLE MEASURED

360 - MEASURED ANGLE

DEFLECTION ANGLE MEASURED

180 $\pm$ MEASURED ANGLE

CHECK FOR ANGULAR ERROR, COMPARE TO THE ALLOWABLE ERROR CRITERION AND CORRECT THE ANGLES

CHECK FOR ANGULAR ERROR

$$E = |\sum A_i - (N-2)(180)|$$

COMPARE TO THE ALLOWABLE ERROR, WHERE IT SHOULD BE FOUND THAT

$$E \leq \sqrt{N}\ \epsilon$$

ϵ: NEAREST VALUE TO WHICH AN ANGLE IS RECORDED (USE $\epsilon/2$ IF THE ANGLE IS DOUBLED)

N: THE NUMBER OF STATIONS IN THE TRAVERSE

A_i: THE INTERIOR ANGLE FOR STATION i

CORRECT THE ANGLES, A_i, BY DISTRIBUTING THE ERROR AMONG THEM SO THAT

$$\sum A_i = (N-2)(180)$$

PROCEDURE

1. DISTRIBUTE THE ERROR MORE OR LESS EVENLY OVER ALL OF THE TRAVERSE POINTS
2. DISTRIBUTE THE ERROR AMONG THOSE STATIONS WHERE THE ERROR MOST LIKELY OCCURRED

BOTH PROCEDURES REQUIRE GOOD JUDGMENT

ADD ADJUSTMENTS IN MULTIPLES OF ϵ - DO NOT END UP WITH ANGULAR VALUES THAT SUGGEST ANGLES WERE MEASURED TO A VALUE SMALLER THAN ϵ

FAVOR ADJUSTMENTS TO ANGLES ON STATIONS WITH SHORT DISTANCES AND STEEP VERTICAL ANGLES

COMPUTE THE BEARINGS OF THE LINES USING THE CORRECTED ANGLES

SELECT A LINE FROM WHICH TO START THE CALCULATIONS

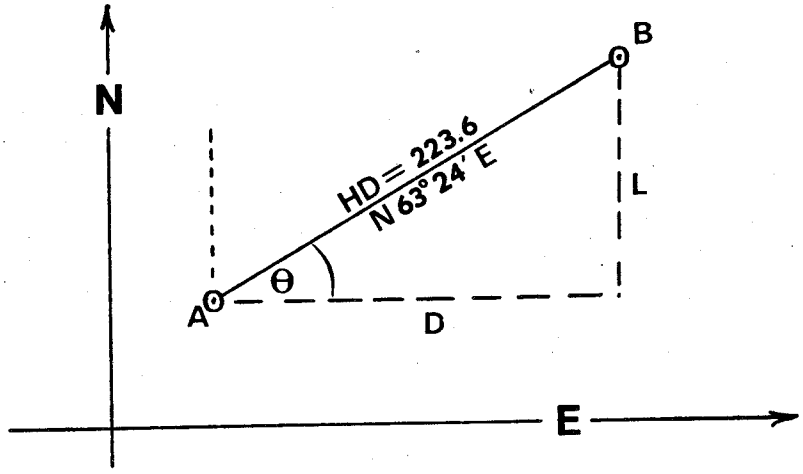
A LINE FOR WHICH THE CORRECT BEARING IS KNOWN (SUNSHOT)

A LINE FOR WHICH IT IS MOST LIKELY THAT THE BEARING IS CORRECT (B.S. EQUALS THE F.S. ALONG THE LINE)

A LINE AND BEARING SELECTED AS BEING CONVENIENT (LINE AND BEARING USED ON A PREVIOUS SURVEY)

STARTING WITH THE BEARING OF THAT FIRST LINE CALCULATE THE BEARINGS OF THE FOLLOWING LINES MOVING SEQUENTIALLY AROUND THE TRAVERSE

CALCULATE THE LATITUDE AND DEPARTURE OF EVERY LINE ON THE TRAVERSE



FOR THE DIRECTED LINE $\vec{AB}$

GIVEN: BEARING N63°24'E

H.D. 223.6'

FIND: LATITUDE, L

DEPARTURE, D

CALCULATIONS:

$\theta = 90° - 63.4° = 26.6°$

$D = (223.6)(\sin 26.6) = 100.1$

$L = (223.6)(\cos 26.6) = 199.9$

NOTE:

$$\text{SIGN}[L] = \begin{cases} + & \text{IF MOVEMENT NORTH} \\ - & \text{IF MOVEMENT SOUTH} \end{cases}$$

$$\text{SIGN}[D] = \begin{cases} + & \text{IF MOVEMENT EAST} \\ - & \text{IF MOVEMENT WEST} \end{cases}$$

E.G. FOR LINE $\vec{BA}$

$L = -100.1$

$D = -199.9$

CALCULATE THE ERROR OF CLOSURE AND COMPARE TO DESIRED PRECISION

SUM ALL OF THE LATITUDES AROUND THE TRAVERSE

$$\sum L_i$$

SUM THE DEPARTURES FOR ALL OF THE LINES

$$\sum D_i$$

SUM ALL OF THE HORIZONTAL DISTANCES

$$\sum HD_i$$

CALCULATE THE ERROR OF CLOSURE

[redacted] $= \sqrt{(\sum L)^2 + (\sum D)^2}$

$$\sum HD$$

IT SHOULD BE FOUND THAT

ERROR OF CLOSURE $\leq$ DESIRED PRECISION

CORRECT THE ERROR BY BALANCING LATITUDES AND DEPARTURES THROUGH THE ADJUSTMENT OF THE LATITUDE AND DEPARTURE OF EVERY LINE OF THE TRAVERSE

COMPASS RULE

$$L_i^c = L_i - \left[\sum L\right]\left[\frac{HD_i}{\sum HD}\right]$$

$$D_i^c = D_i - \left[\sum D\right]\left[\frac{HD_i}{\sum HD}\right]$$

CALCULATE THE TOTAL LATITUDE AND TOTAL DEPARTURE OF EVERY POINT AND PLOT THE TRAVERSE

ARBITRARILY ASSIGN A TOTAL LATITUDE AND A TOTAL DEPARTURE COORDINATE TO ONE OF THE STATIONS OF THE TRAVERSE

CAN BE SELECTED FOR CONVENIENCE OF PLOTTING

THE USUAL APPROACH IS TO ASSIGN THE COORDINATES (10,000 10,000) TO THE FIRST STATION ON THE TRAVERSE

$$TD_0 = 10000$$

$$TL_0 = 10000$$

THEN

$$TD_J = TD_0 + \sum_1^J D_i$$

$$TL_J = TL_0 + \sum_1^J L_i$$

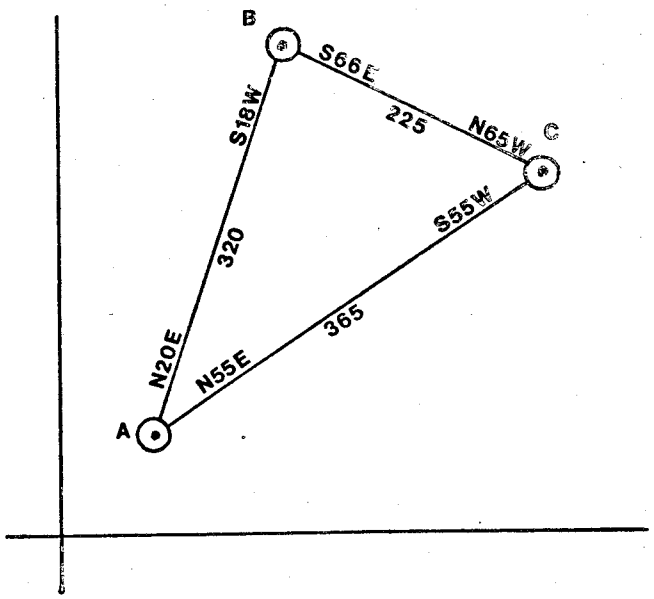
RECALCULATE THE BEARINGS AND DISTANCES FOR ALL OF THE LINES

CLOSED TRAVERSE EXAMPLE

FIELD DATA

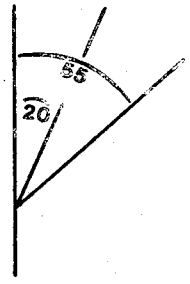
STA.	H.D.	F.S.	B.S.
A			
	365	S55W	N55E
C			
	225	S66E	N65W
B			
	320	N20E	S18W
A			

SKETCH



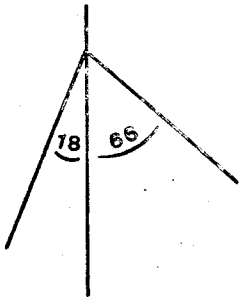
CALCULATE THE INTERIOR ANGLES

CAB



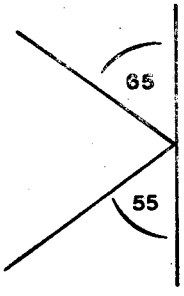
$55 - 20 = 35$

ABC



$66 + 18 = 84$

BCA



$180 - (65 + 55) = 60$

CHECK FOR ANGULAR ERROR AND CORRECT

$$\text{ERROR} = |(35 + 84 + 60) - (3 - 2)(180)|$$

$$\text{ERROR} = 1^\circ$$

IF THE ANGLE WAS READ TO THE NEAREST DEGREE

$$1^\circ \leq (\sqrt{3})(1^\circ)$$

IT IS WITHIN THE ALLOWABLE ERROR

CORRECT THE ANGLES SO THAT

$$\sum A_i = 180^\circ$$

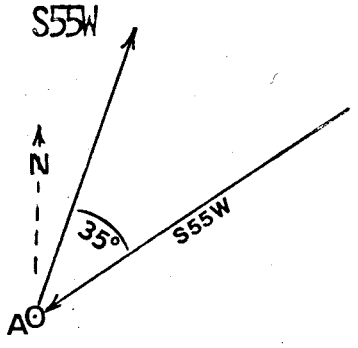
ADD 1° TO THE ANGLE ABC

SHORTEST DISTANCES, AND EXAMINATION OF THE DATA SUGGESTS THAT THE ERROR OCCURRED THERE

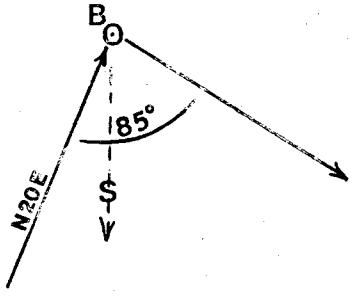
COMPUTE BEARINGS

DIRECTION $\vec{AC}$ AGREES WITH $\vec{CA}$ THEREFORE SELECT THIS LINE TO START CALCULATIONS

BRG $\vec{CA}$ S55W



BRG $\vec{AB}$ N20E



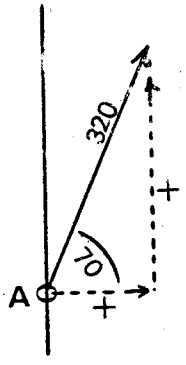
BRG $\vec{BC}$ S65E

$LAT = HD * COS(BRG)$

$DEP = HD * SIN(BRG)$

CALCULATE LATITUDES AND DEPARTURES

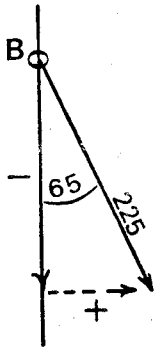
$\vec{AB}$



$L = (320)(COS\ 20^\circ) = 300.7$

$D = (320)(SIN\ 20^\circ) = 109.4$

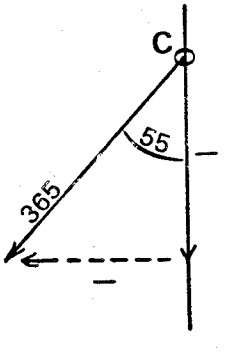
$\vec{BC}$



$L = -(225)(COS\ 65) = -95.1$

$D = (225)(SIN\ 65) = 203.9$

$\vec{CA}$



$L = -(365)(COS\ 55) = -209.4$

$D = -(365)(SIN\ 55) = -299.0$

CALCULATE THE ERROR OF CLOSURE

	LATITUDE OF LINE	DEPARTURE OF LINE	HORIZONTAL DISTANCE
$\vec{AB}$	300.7	109.4	320
$\vec{BC}$	- 95.1	203.9	225
$\vec{CA}$	-209.4	-299.0	365
TOTAL	- 3.8	14.3	910 ✓

ERROR OF CLOSURE = $\sqrt{(-3.8)^2 + (14.3)^2}$ = 14.6

PRECISION = .016 = $\frac{1}{62.5}$ ✓

MARGINAL EVEN FOR HAND COMPASS AND PACING

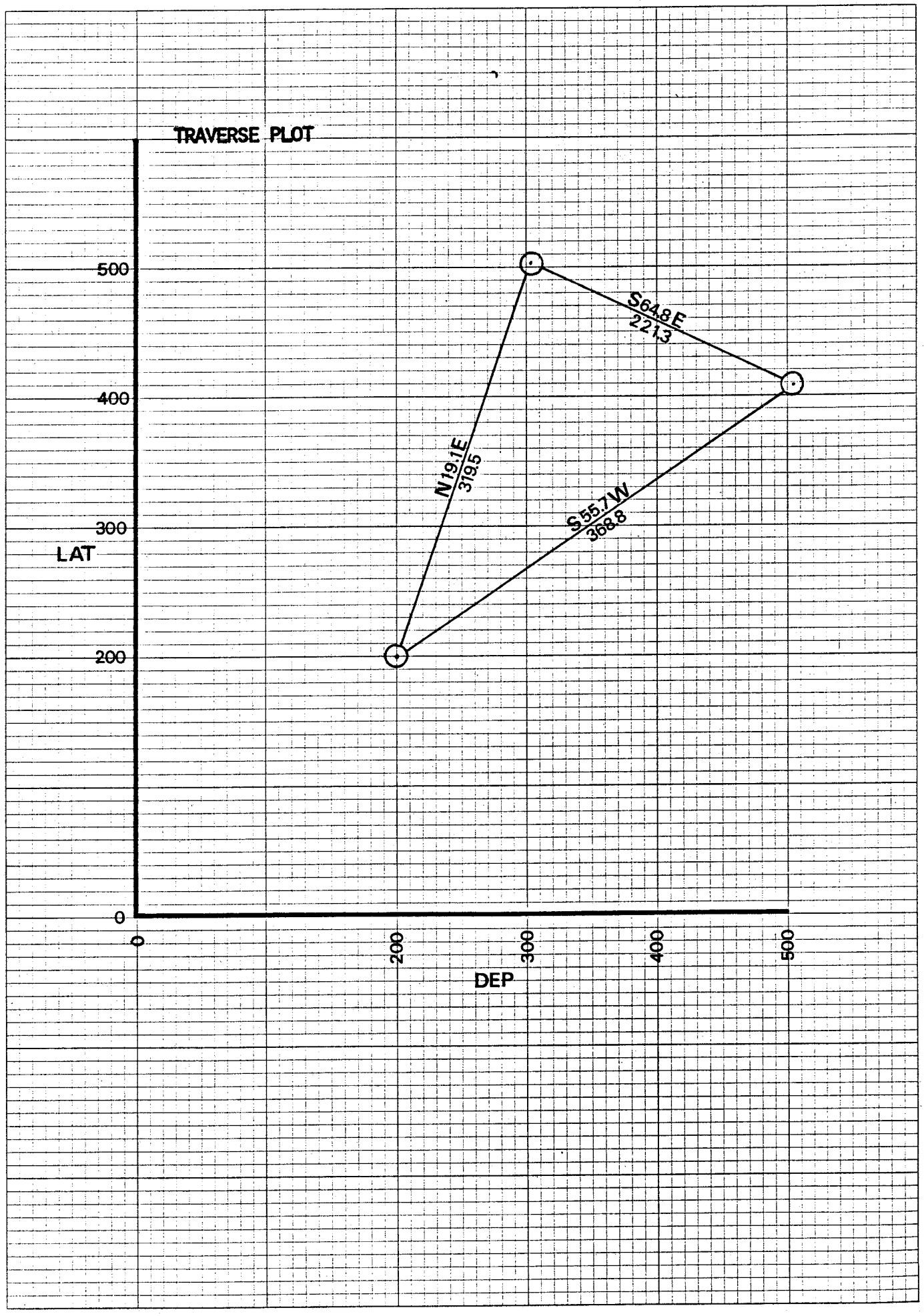
BALANCE LATITUDES AND DEPARTURES

	L	D	$(HD_i/\Sigma HD)$	L^c	D^c
AB	300.7	109.4	.352	302.0	104.4
BC	- 95.1	203.9	.247	- 94.2	200.3
CA	-209.4	-299.0	.401	-207.8	-304.7
TOTAL	- 3.8	14.3	1.000	0.0	0.0

CALCULATE TOTAL LATITUDE AND TOTAL DEPARTURE

STA.	TOTAL LATITUDE	TOTAL DEPARTURE
A	200.0	200.0
B	502.0	304.4
C	407.8	504.7
A	200.0	200.0

(Coordinates)



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