

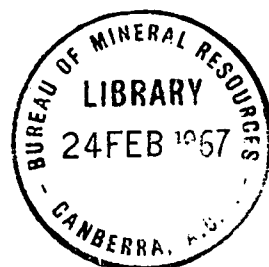
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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/207



CORRECTIONS FOR ABSOLUTE AND
SEMI-ABSOLUTE MAGNETIC
INSTRUMENTS

by

C.A. van der Waal

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or use in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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- Plate 31. Instrument corrections for BMZ 221 (G82/2-45)
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1. INTRODUCTION

This report contains the results of an investigation into the corrections to the absolute and semi-absolute magnetic instruments used by the Bureau of Mineral Resources from 1949 onwards.

Because most international comparisons have been made against Rude Skov, Denmark, it was decided to base all corrections on this station.

The comparison observations have been adjusted where necessary, applying the latest (and usually final) scale values, temperature corrections, and pier and hut differences. Corrections to the Toolangi instruments were adopted first. These were based on comparisons with other world standards, generally with that of Rude Skov. Thus a final Toolangi standard was fixed in terms of corrections to the absolute instruments used at Toolangi, and baseline values were adopted in accordance with this standard. All corrections to other instruments are based on either these adopted baseline values or direct comparisons with overseas standards and the proton precession magnetometer.

From March 1959, the new absolute house at Toolangi was used, but the values have been reduced to the old absolute house. This was done because it was proposed to install the proton precession magnetometer in the old house.

It is pointed out that the number of international observations is very limited and that the corrections adopted for the Toolangi instruments are the best obtainable with this limited number of comparisons. However, observations confirm that the adopted corrections agree with the proton precession magnetometer to within a few gammas.

2. METHOD OF OBTAINING INSTRUMENT CORRECTIONS

As already stated the corrections of all instruments are based on the Toolangi station magnetometers and, when available, values obtained by international comparisons were included. In recent years some corrections were obtained by direct comparison with the proton precession magnetometer.

The corrections for the Toolangi instruments were adopted first. For the H instruments these are based on comparisons with Rude Skov and the proton magnetometer. Some values were obtained from international comparison instruments sent from Rude Skov by IAGA Committee 7, and some from the mean of readings of a number of new instruments calibrated there. In one instance a set of three JHMs was sent from Toolangi for recalibration at Rude Skov. The more recent values were obtained by comparison with the proton magnetometer.

Until August 1955, Z baselines were obtained directly from the Schulze Earth inductor. After this date, BMZ 119 was used and this instrument was, from time to time, compared with the Earth inductor, and in later years with the proton magnetometer.

D baselines were obtained with the declinometers belonging to Elliott No. 18, CIW No. 18, Askania 508810, and Ruska 4813.

Before May 1955, comparison instruments were compared directly with the Toolangi absolute instruments. Toolangi baselines were obtained from the observed values of the Toolangi absolute instruments after applying the instrument correction.

From May 1955 until June 1963, instruments were compared with Toolangi baselines; after 1963 they were compared by simultaneous observations again. To obtain Toolangi baselines all observed baseline values were plotted. These values include the adopted corrections for the Toolangi instruments.

As it was shown by Small (1965) that fluctuations in the H baselines were real, the Toolangi baseline values used for comparisons were, as far as possible, adopted from observations made on the same day.

If no baseline observations were made on the same day, the overall plots were carefully examined, and the best baseline value adopted.

However, it was found that this method of comparing instruments through baselines is not always accurate and lately simultaneous observations have been used. In future, instruments will be compared by simultaneous observations whenever possible.

3. INSTRUMENTS

For measuring horizontal intensity

The following instruments are at present used for H observations:

Askania HTM 154	Comparison observations
QHMs 172, 173, 174	Comparison observations
QHMs 177, 178, 179	Macquarie Island
QHMs 187, 188, 189	Port Moresby
QHMs 288, 289, 290	Toolangi
QHMs 291, 292, 293	Gnangara
QHMs 300, 301, 302	Mawson
QHMs 305, 306	Regional surveys
QHMs 460, 461, 462	Comparison observations
QHMs 492, 493, 494	Wilkes

For measuring declination

For D observations the following instruments are at present in use :

Ruska 4813	Toolangi
Askania fibre declinometer	
509319	Gnangara
Askania fibre declinometer	
509320	Comparison observations
Askania fibre declinometer	
580333	Port Moresby
Askania fibre declinometer	
580339	Comparison observations
Askania fibre declinometer	
630332	Mawson
Askania fibre declinometer	
630505	Macquarie Island
Askania fibre declinometer	
640506	Wilkes
Askania fibre declinometer	
640812	Regional surveys

For measuring vertical intensity

For Z observations the following instruments are used :
(L.R. indicates a 'long-range' instrument with adjustable field magnet).

BMZ 62	Mawson
BMZ 64	Macquarie Island
BMZ 68	Port Moresby
BMZ 115(L.R.)	Comparisons and regional surveys
BMZ 119	Toolangi
BMZ 120	Gnangara
BMZ 121(L.R.)	Comparisons and regional surveys
BMZ 211(L.R.)	Comparisons and regional surveys
BMZ 221(L.R.)	Comparisons and regional surveys
BMZ 236	Wilkes

The histories of these and some other instruments that have been used are given below.

Elliott magnetometer No. 18

Elliott magnetometer No. 18 was used as an absolute instrument at Toolangi for H and D measurements until January 1951.

It was compared with international QHMs 33, 51, and 52 in 1949 and 1950 and with the CIW No. 18 in 1951. The correction to the Elliott No. 18 obtained from CIW No. 18 was approximately the same as the mean of the international comparisons.

From 1952 to 1954 it was used for regular declination control observations at Heard Island.

It has not been used since then and is now obsolete.

CIW magnetometer No. 7

This instrument was used at Watheroo from 1919, when that observatory was established, until 1953, when it was replaced by Askania magnetometer No. 508810.

The instrument correction used before January 1948 was :

$$H_{\text{corr'n}} = [-74 + 5.2 (1926.0 - t)] \text{ gammas per gauss}$$

where t is the date in years.

Based on later information this formula was changed to :

$$H_{\text{corr'n}} = [-160 + 3 (1950.0 - t)] \text{ gammas per gauss}$$

This formula was used from 1948 to 1953. The instrument has not been used since 1953.

CIW magnetometer No. 18 (Plate 1)

This instrument replaced the Elliott No. 18 in January 1951 and was used until October 1951. It was then replaced by the Askania magnetometer No. 508813.

Since then it was used as a field instrument for regional magnetic work until 1958, but it is now worn out and no longer used.

CIW magnetometer No. 16

This magnetometer was received from the USA in August 1953 and was used for regional magnetic field observations until 1958. The instrument is now obsolete and no longer used.

CIW magnetometer No. 28

CIW No. 28 was received on loan from the USCGS in 1959 when the Antarctic station at Wilkes was handed over to the Australian Government.

It was used for H, D, and I observations during 1959. At the beginning of 1960 it was replaced by QHM and BMZ for H and Z observations. It was then used for D only until the beginning of 1965 when it was replaced by Askania fibre declinometer No. 640506.

Ruska magnetometer 4813 (Plate 2)

The Ruska magnetometer is permanently stationed at Toolangi. It was used as a standard instrument at Toolangi from September 1954 to June 1955.

The number of comparisons for H is very limited, only four being done between 1953 and 1962.

The best fitting straight line was drawn through these points and taken as representing the instrument correction. It appears that this instrument is drifting by +1.9 gammas per annum.

The Ruska continues to be used for D and the original correction of -0.3 minute is being applied.

Askania magnetometer 508810 (Plate 3)

This instrument has been used as the Watheroo and Gnangara absolute instrument for H and D since 1953.

It has been compared for H with instruments from Toolangi a number of times, and once with a set of international QHMs from Rude Skov. In 1961 it was replaced for H with a set of QHMs and it has since been used for declination observations only.

Note. The above magnetometer number (508810) is the serial number of the metal circle which was supplied with this instrument. However, this circle was replaced by glass circle No. 580135 but the instrument is still known by its original circle number.

Askania magnetometer No. 508813 (Plate 4)

The magnetometer was used as absolute instrument at Toolangi from October 1951 to August 1954, when it was replaced by the Ruska.

Only the declinometer and circle belonging to this instrument are still used.

Note. The magnetometer number (508813) is the serial number of the metal circle which came originally with the instrument. The instrument is still known by this number although the circle is now used for field work.

Askania magnetometer No. 580135

Only the circle and declinometer that belong to this instrument are still being used.

HTMs 154, 158, and 704 (Plate 5)

The fibre of HTM 154 has a low torsion coefficient and therefore this instrument is used only for comparisons of instruments at the Antarctic stations. At Toolangi it is usually used with 4π of torsion.

HTM 158 was used for regional magnetic work. It was usually compared at Toolangi before and after a survey and the mean of the instrument correction thus obtained was used to correct the results of that survey. The fibre of this HTM broke in 1962 and because of the excessive cost it will not be repaired.

HTM 704 was also used for regional surveys. In 1960 the fibre was broken and a new fibre fitted. However, in 1962 the fibre broke again and it will not be repaired.

QHMs 172, 173, and 174 (Plate 6)

These QHMs were used at Heard Island from 1952 to 1954.

The fibre of QHM 173 was broken on its return to Melbourne and repaired by the manufacturers in 1961. New constants were determined at Rude Skov.

QHMs 172 and 174 were used in Darwin from June 1957 to December 1959.

The instruments are now used for comparison of station instruments at Antarctic and other observatories.

QHMs 177, 178, and 179 (Plates 7 & 20)

These instruments have been used at Macquarie Island since 1952 for control observations.

Two QHMs are used at Macquarie Island every year and the third is returned to Melbourne for comparison with the Toolangi instruments.

The two remaining instruments are compared at Macquarie with an instrument brought from Melbourne for this purpose.

The instruments were also used for declination from 1952 to the end of 1955.

QHMs 187, 188, and 189 (Plate 8)

In 1952 to 1953 these instruments were temporarily used at Watheroo and they have been permanently stationed at Port Moresby since 1957.

They have been regularly compared with instruments from Toolangi and once with international QHMs sent from Rude Skov.

QHMs 288, 289, 290 (Plate 9)

These instruments are permanently stationed at Toolangi. The corrections of these instruments were determined by comparison with new instruments received from Denmark, international comparisons, and the proton magnetometer.

The mean of these three instruments, corrected by the adopted corrections shown in Plate 9, has been taken as the Toolangi standard since 1955. Therefore the determination of instrument corrections for all other H instruments after May 1955 are based on the adopted corrections for these QHMs.

QHMs 291, 292, and 293 (Plate 10)

These instruments have been used in Watheroo since 1955 and are now used at Gnangara as control instruments for the recording variometers.

They have been regularly compared with instruments from Toolangi and the proton magnetometer.

QHMs 300, 301, and 302 (Plates 11 & 19)

These instruments are used at Mawson for control of the recording variometers.

Two QHMs are used at Mawson while the third is returned to Melbourne for comparison at Toolangi.

Comparisons are also carried out every year during the change-over period with instruments brought from Melbourne.

From 1955 to 1963 QHM 300 was also used for declination observations, but since the beginning of 1964, Askania fibre declinometer 630332 was used for this.

QHMs 305 and 306 (Plate 12)

These instruments are used for regional surveys. They are compared at Toolangi before and after each survey and the instrument correction is determined for the survey period.

QHMs 460, 461, and 462 (Plate 13)

These instruments are used mostly for comparisons.

In November 1960 they were sent to Rude Skov for redetermination of constants. They were compared at Toolangi before and after

this and a check on the Toolangi instrument correction was thus obtained. After return from Rude Skov they were also sent to Port Moresby and Gwangara for comparison with their permanent station instruments to check their instrument corrections.

QHMs 492, 493, and 494 (Plate 14)

These QHMs are permanently stationed at Wilkes. QHMs 492 and 494 are used for absolute observations and QHM 493 is used for field work.

Every year, during the change-over period, they are compared with instruments brought from Toolangi.

Askania fibre declinometer No. 509319 (Plate 15)

This declinometer is part of Askania magnetometer 508810 and is used permanently at Gwangara for variometer control observations.

Askania fibre declinometer No. 509320 (Plate 16)

This instrument is used for comparison observations and regional magnetic surveys.

Askania fibre declinometer No. 580333 (Plate 17)

This declinometer has been used permanently at Port Moresby for variometer control observations since 1960. It is used with circle No. 580146.

Askania fibre declinometer No. 580339 (Plate 18)

This instrument is also used for comparison observations and regional magnetic surveys.

Askania fibre declinometer No. 630332

Declinometer 630332 has been the permanent Mawson control instrument for D since 1964. It replaced QHM 300 for D observations.

Askania fibre declinometer No. 630812

This instrument is used for regional magnetic surveys.

Askania fibre declinometer No. 640505

This declinometer was sent to Macquarie Island at the end of 1964 to replace the DCK 158.

Askania fibre declinometer No. 640506

This was sent to Wilkes in January 1965 to replace the CIW 28 declinometer.

DCK 158 (Plate 21)

This instrument has been used for D observations at Macquarie Island from 1956 until the end of 1964 when it was replaced by Askania fibre declinometer No. 640505.

Schulze Earth inductor No. 49

The Schulze Earth inductor was used for inclination observation at Toolangi until August 1955, when it was replaced by BMZ 119.

Toepfer Earth inductor No. 2

This Earth inductor was used as absolute instrument at Watheroo until it was replaced by BMZ 120 in 1955.

Askania Earth inductor No. 5111079

This instrument has been used at Port Moresby to check the instrument correction to BMZ 68 but is now not used any longer.

Askania Earth inductor No. 5111081

This Earth inductor was used in Watheroo a few times in an effort to check the instrument correction for BMZ 120.

The instrument is no longer used.

BMZ 62 (Plate 23)

This BMZ has been permanently stationed at Mawson since 1956.

In October 1955, before it was sent to Mawson, it was compared with long-range BMZ 121 at Byron Bay.

At Mawson it is compared every year during the change-over period with a long-range BMZ sent from Melbourne, and in recent years with the proton magnetometer.

BMZ 64 (Plate 24)

This is the permanent Macquarie Island instrument.

Comparisons are made during the change-over period with long-range BMZs from Melbourne, and recently with the proton magnetometer.

BMZ 68 (Plate 25)

This BMZ has been permanently used at Port Moresby since 1957.

A few comparisons were made with the Askania Earth inductor No. 5111001 and the proton magnetometer.

BMZ 115 (Plate 26)

This is a long-range BMZ and is used for comparison observations. It has only one compensating magnet (A) with a range from -6900 to -28900 gammas.

BMZ 119 (Plate 27)

This is the Toolangi BMZ on which all vertical intensity instrument corrections since 1955 are based.

The observations are fairly scattered and the correction obtained from the comparison with the Schulze Earth inductor in December 1960 to January 1961 is doubtful, i.e. it seems that the correction to the Schulze Earth inductor has changed. An instrument correction of + 38 gammas was adopted from 1955. After the more recent comparisons with the proton magnetometer it was found that the correction is now + 32 gammas. It was decided to make this change in two steps of 3 gammas on 1st January 1964 and 1st January 1965.

BMZ 120 (Plate 28)

This BMZ is permanently stationed at Gnangara.

It appears that two jumps occurred to this instrument, one of about -27 gammas between July 1956 and November 1957 and one of -250 gammas in July 1958.

If the observations with Askania Earth inductor in August 1956 are reliable the first jump must have occurred shortly after 24th July 1956. However, the baseline values show no evidence of this jump.

The second jump of -250 gammas is real and shows in the baseline values.

BMZ 121 (Plate 29)

This is a long-range BMZ and is used for comparisons only.

It has three compensating magnets with the following ranges:

Magnet A -69000 to -29000 gammas
 Magnet B -32000 to -13000 gammas
 Magnet C -15500 to -5500 gammas

BMZ 211 (Plate 30)

This is a long-range BMZ used for comparison observations.

Between December 1958 and November 1959 a jump occurred in this instrument of about 160 gammas.

Comparisons with this instrument were made against Toolangi baseline values and recently by simultaneous observations.

Three compensating magnets belong to this instrument. Their ranges are :

Magnet A -4500 to -14000 gammas
 Magnet B -12000 to -31500 gammas
 Magnet C -30000 to -70000 gammas

BMZ 221 (Plate 31)

This is a long-range BMZ and is used for comparison of other instruments.

The three compensating magnets have the following ranges:

Magnet A -71000 to -30000 gammas
 Magnet B -32000 to -12500 gammas
 Magnet C -15000 to -5000 gammas

BMZ 236 (Plate 32)

This BMZ has been used at Wilkes since 1960. It replaced the CIW 28 Earth inductor.

4. REFERENCES

- | | | |
|--------------|------|--|
| SMALL, G. R. | 1965 | Fluctuations in the H-baseline value at Toolangi Observatory, Victoria.
<u>Bur. Min. Resour. Aust. Rec. 1965/235.</u> |
|--------------|------|--|

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INSTRUMENT CORRECTIONS FOR DTMC.IW. No. 18

γ/Γ

0

-20

-40

-60

-80

-100

-120

γ/Γ

Used as
looping
standard
instrument

Δ International comparison

PLATE I

1966/207

INSTRUMENT CORRECTIONS FOR RUSKA MAGNETOMETER 4813

γ at T_0
+10
0
-10
 γ at T_0

Used as
Toolangi
standard
instrument

PLATE 2

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INSTRUMENT CORRECTIONS FOR ASKANIA MAGNETOMETER 508810

γ/Γ
+40
+20
0
-20
 γ/Γ

Δ international comparison

PLATE 3

INSTRUMENT CORRECTIONS FOR ASKANIA 508813

 γ at To

+20

+10

0

 γ at To

Used as Toolong standard instrument

International comparison

PLATE 4

1966/207

INSTRUMENT CORRECTIONS FOR HTM's 154 & 704

γ/Γ

+460

40

HTM 154

+400

80

60

40

20

+300

+60

+40

HTM 704

+20

0

-20

γ/Γ

Fibre broken

Fibre broken

PLATES

Based on
GB2-134

1957

1958

1959

1960

1961

1962

1963

1964

1965

QHM 173

PLATE 6



INSTRUMENT CORRECTIONS FOR QHM's 177, 178 & 179

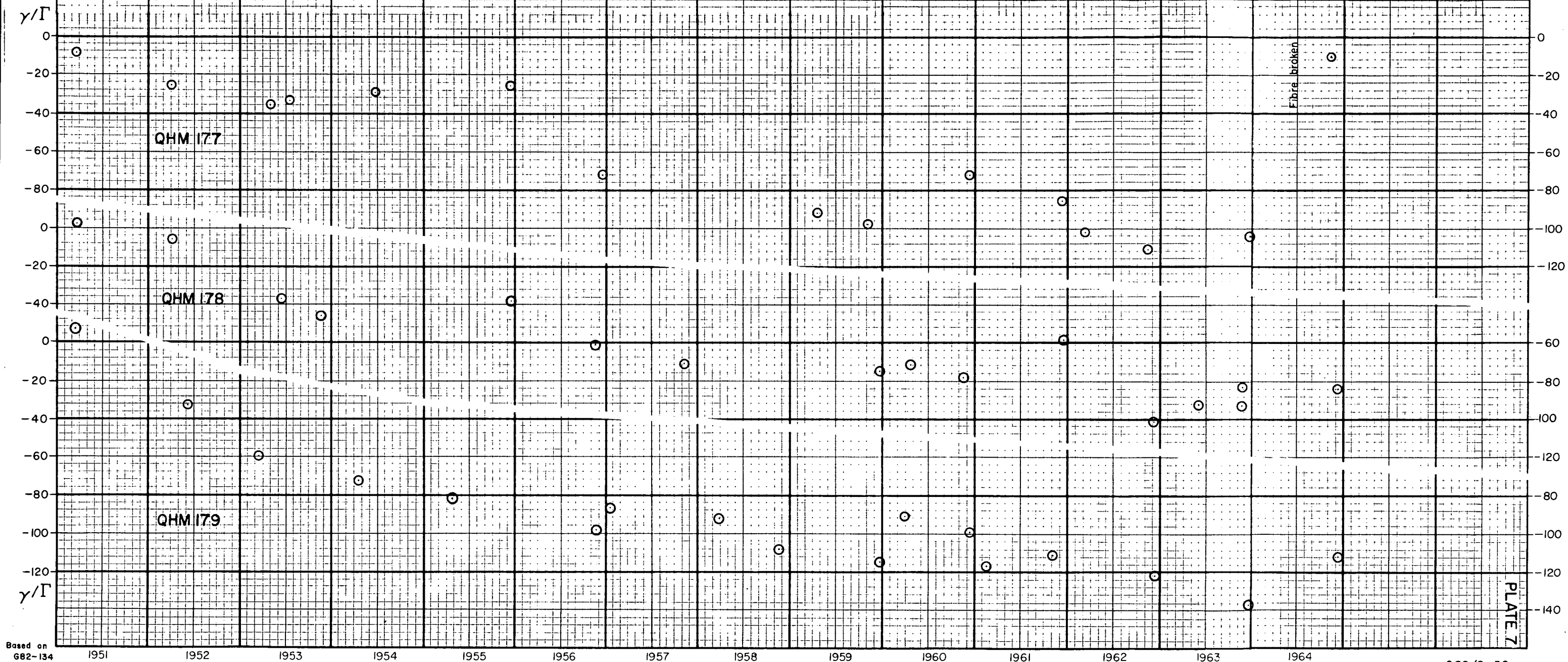
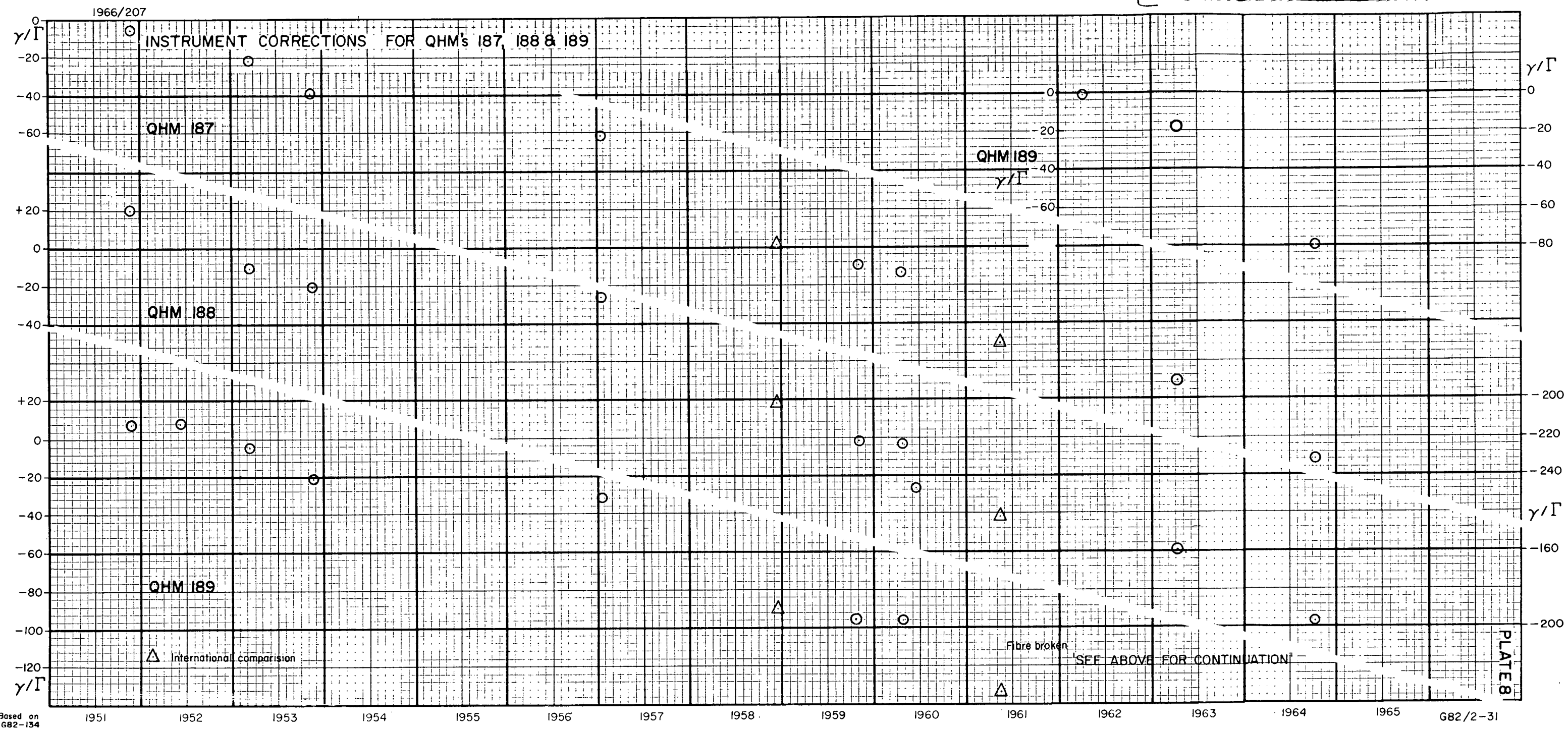


PLATE 7



1966/207

INSTRUMENT CORRECTIONS FOR QHM's 288, 289 & 290

γ at Toolangi

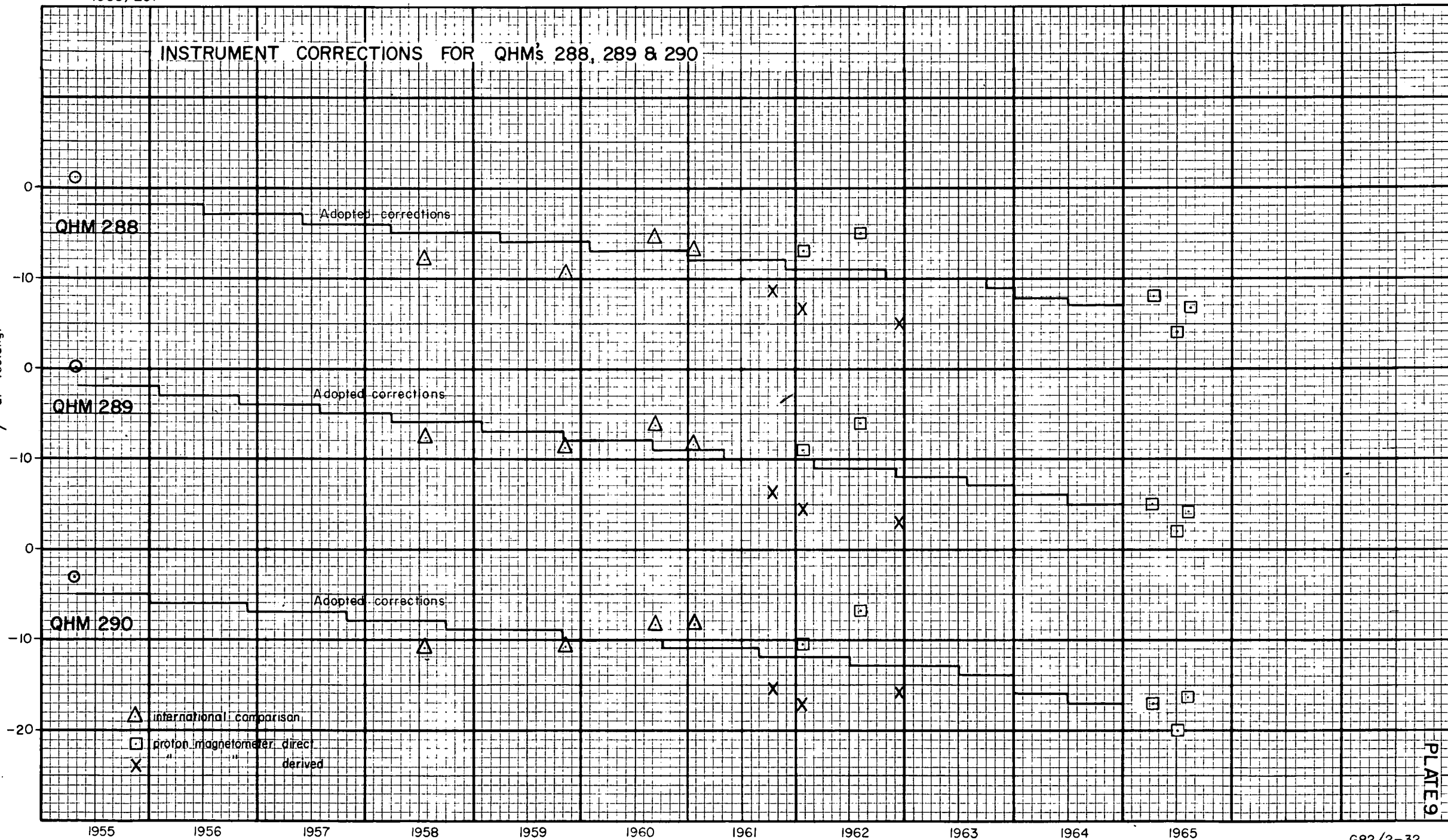


PLATE 9

1966/207

γ/Γ

QHM 291

INSTRUMENT CORRECTIONS FOR QHM's 291, 292 AND 293

+20

0

-20

-40

-60

QHM 292

0

-20

-40

-60

QHM 293

+40

+20

0

-20

-40

γ/Γ

PLATE 10

1966/207

INSTRUMENT CORRECTIONS FOR QHM's 300,301 AND 302

γ/Γ

QHM 300

+40

+20

0

-20

-40

QHM 301

+20

0

-20

-40

QHM 302

+40

+20

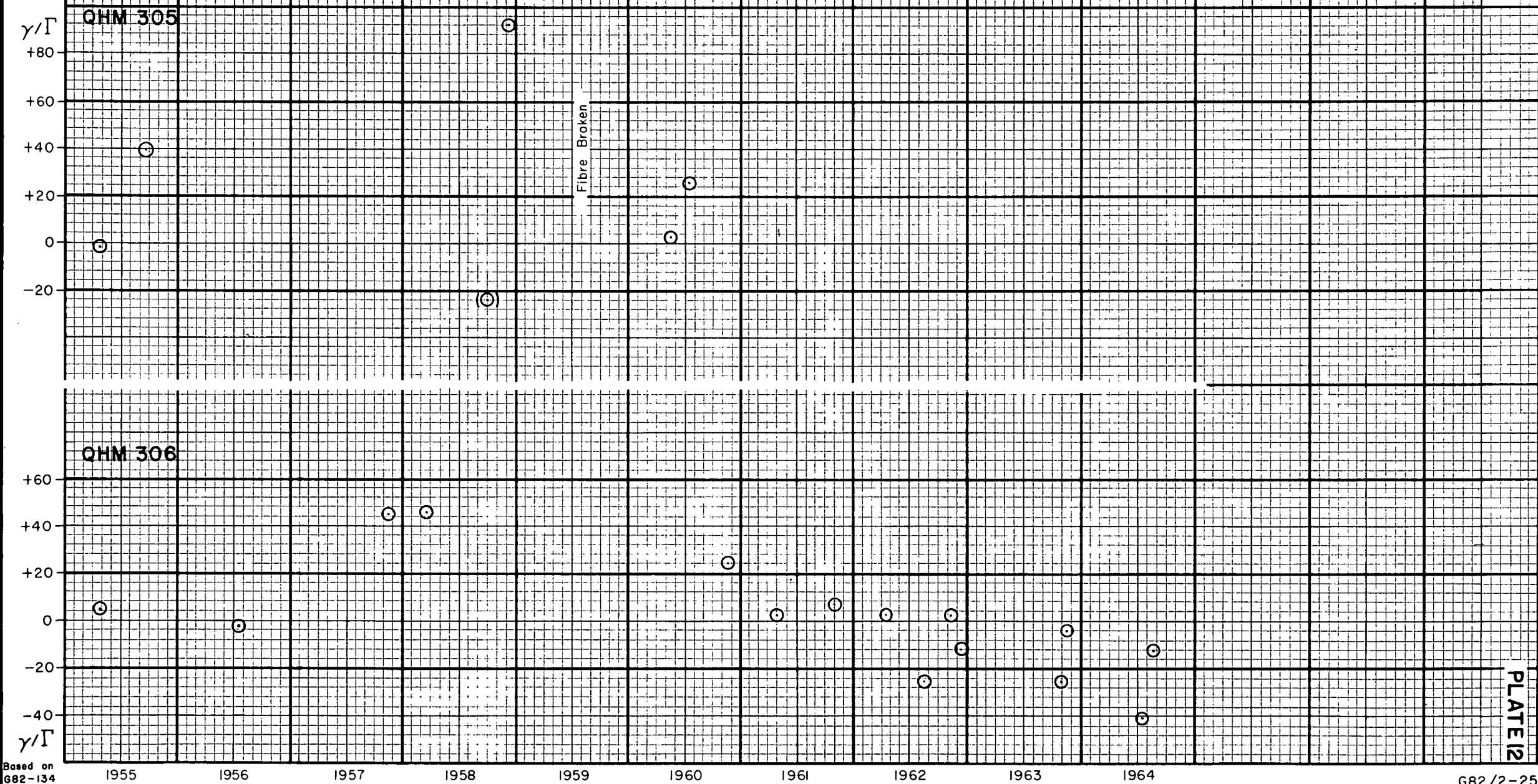
0

-20

γ/Γ

PLATE II

INSTRUMENT CORRECTIONS FOR QHM's 305 AND 306



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INSTRUMENT CORRECTIONS FOR QHM's 460, 461 AND 462

γ/Γ

QHM 460

+40

+20

0

-20

-40

QHM 461

0

-20

-40

-60

QHM 462

+20

0

-20

-40

γ/Γ

Δ International comparison

Change of
constants

Based on
G82-134

1958

1959

1960

1961

1962

1963

1964

PLATE 13

G82/2-26

INSTRUMENT CORRECTIONS FOR QHM's 492, 493 AND 494

γ/Γ

QHM 492

+40
+20
0
-40

γ/Γ

QHM 493

+20
0
-20

γ/Γ

QHM 494

+40
+20
0
-20

γ/Γ

1959 1960 1961 1962 1963 1964 1965

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INSTRUMENT CORRECTIONS FOR ASKANIA DECLINOMETER 509319

MINUTES
+2
+1
0
-1

PLATE 15

1952

1953

1954

1955

1956

1957

1958

1959

1960

1961

1966/207

INSTRUMENT CORRECTIONS FOR ASKANIA DECLINOMETER 509320

MINUTES
+2
+1
0
-1
-2
-3

PLATE 16

1955

1956

1957

1958

1959

1960

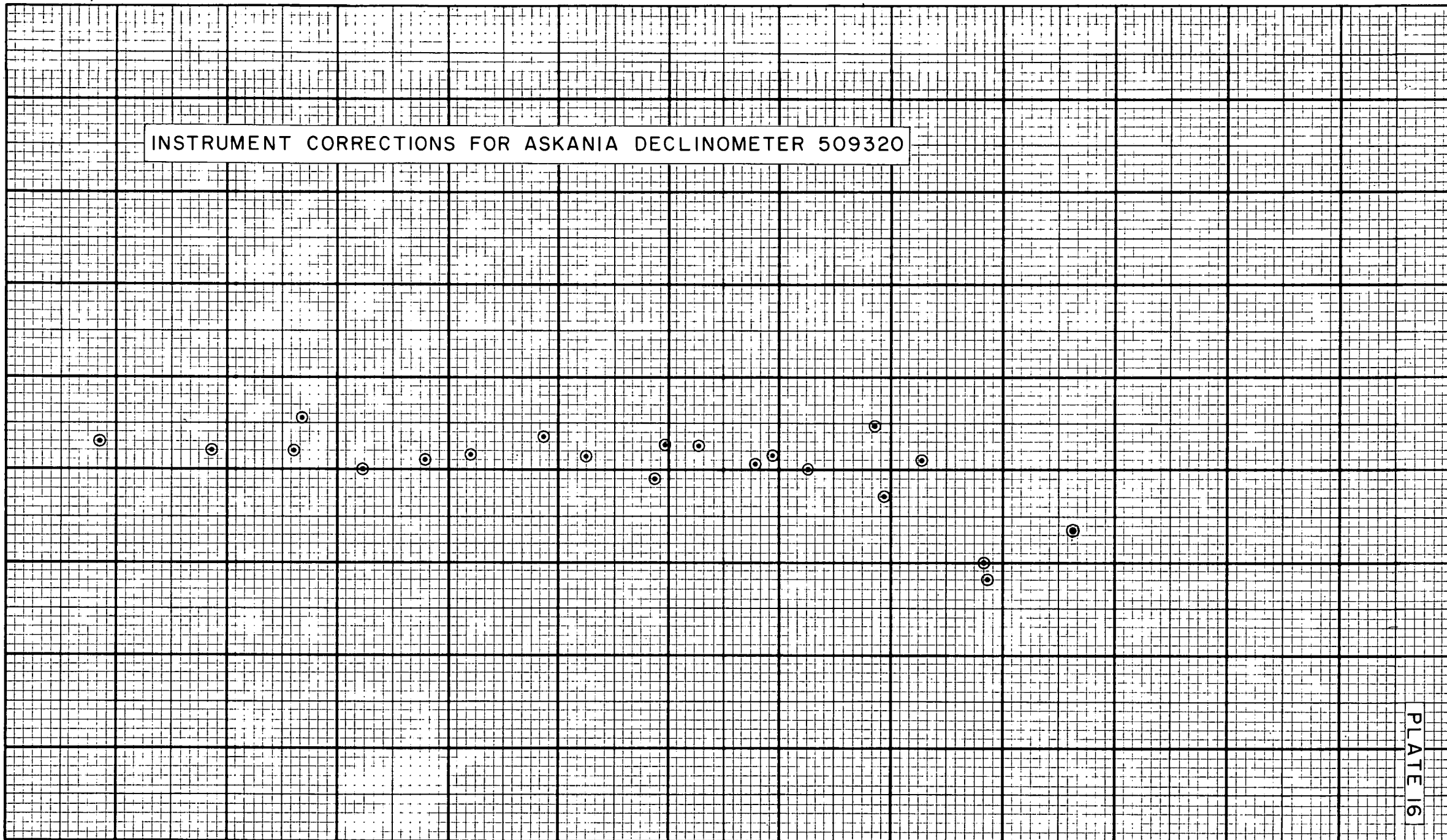
1961

1962

1963

1964

G82/2-36



1966/207

INSTRUMENT CORRECTIONS FOR ASKANIA DECLINOMETER 580333

MINUTES

+1

0

-1

-2

PLATE 17

1960

1961

1962

1963

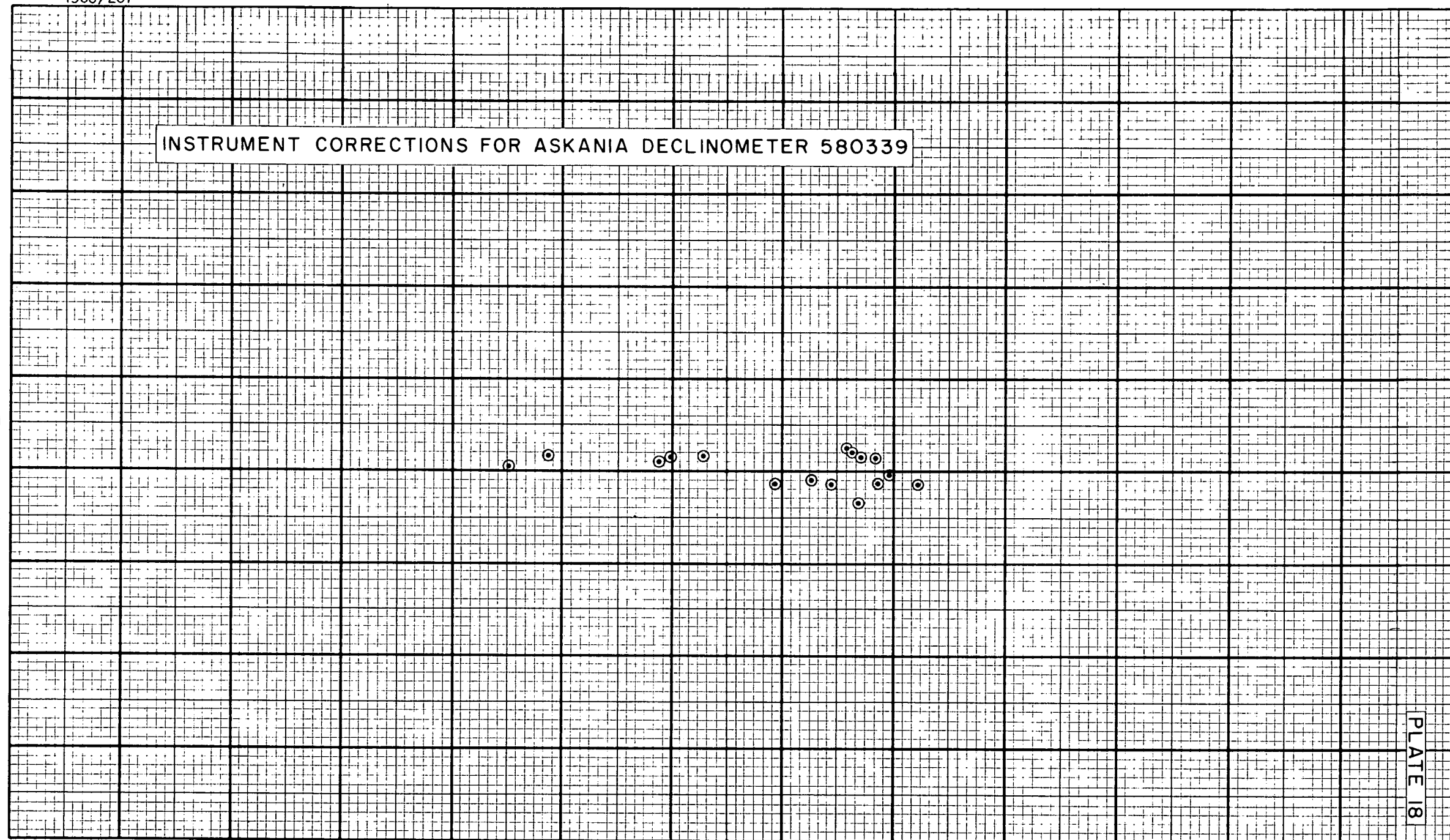
1964

G82/2-47

1966/207

INSTRUMENT CORRECTIONS FOR ASKANIA DECLINOMETER 580339

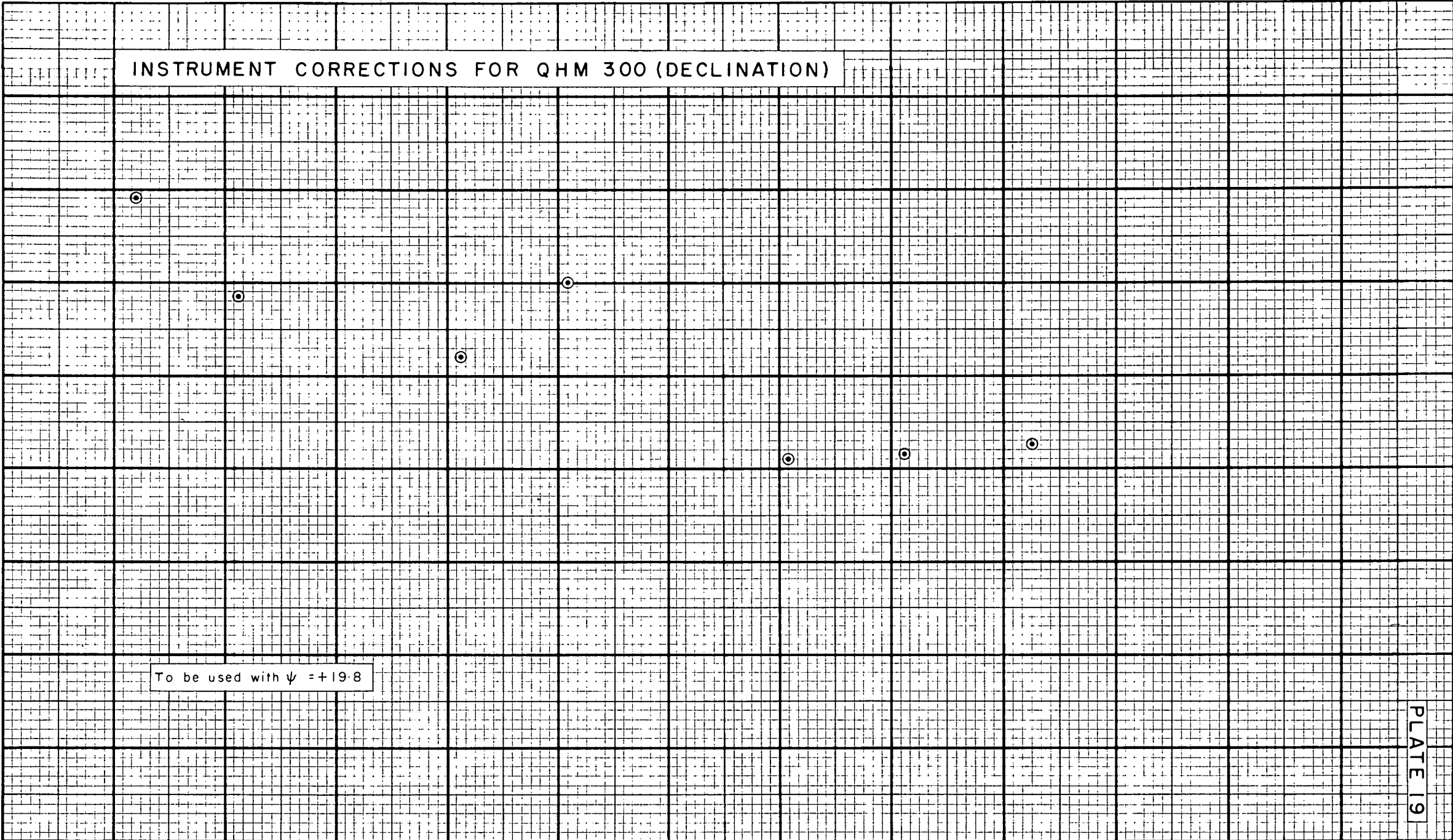
MINUTES
+1
0
-1



INSTRUMENT CORRECTIONS FOR QHM 300 (DECLINATION)

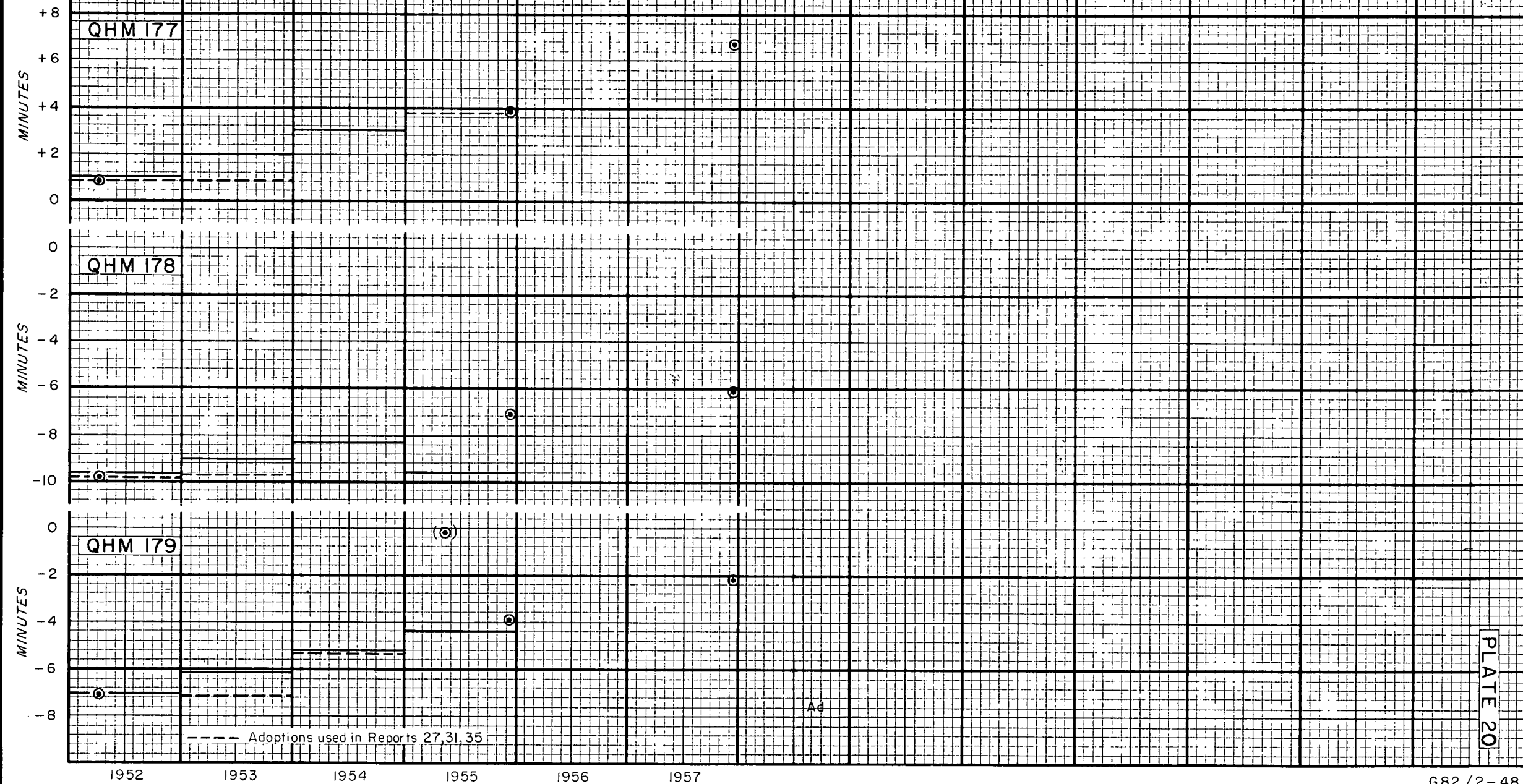
MINUTES
+7
+6
+5
+4
+3
+2
+1
0

To be used with $\psi = +19.8$



1966/207

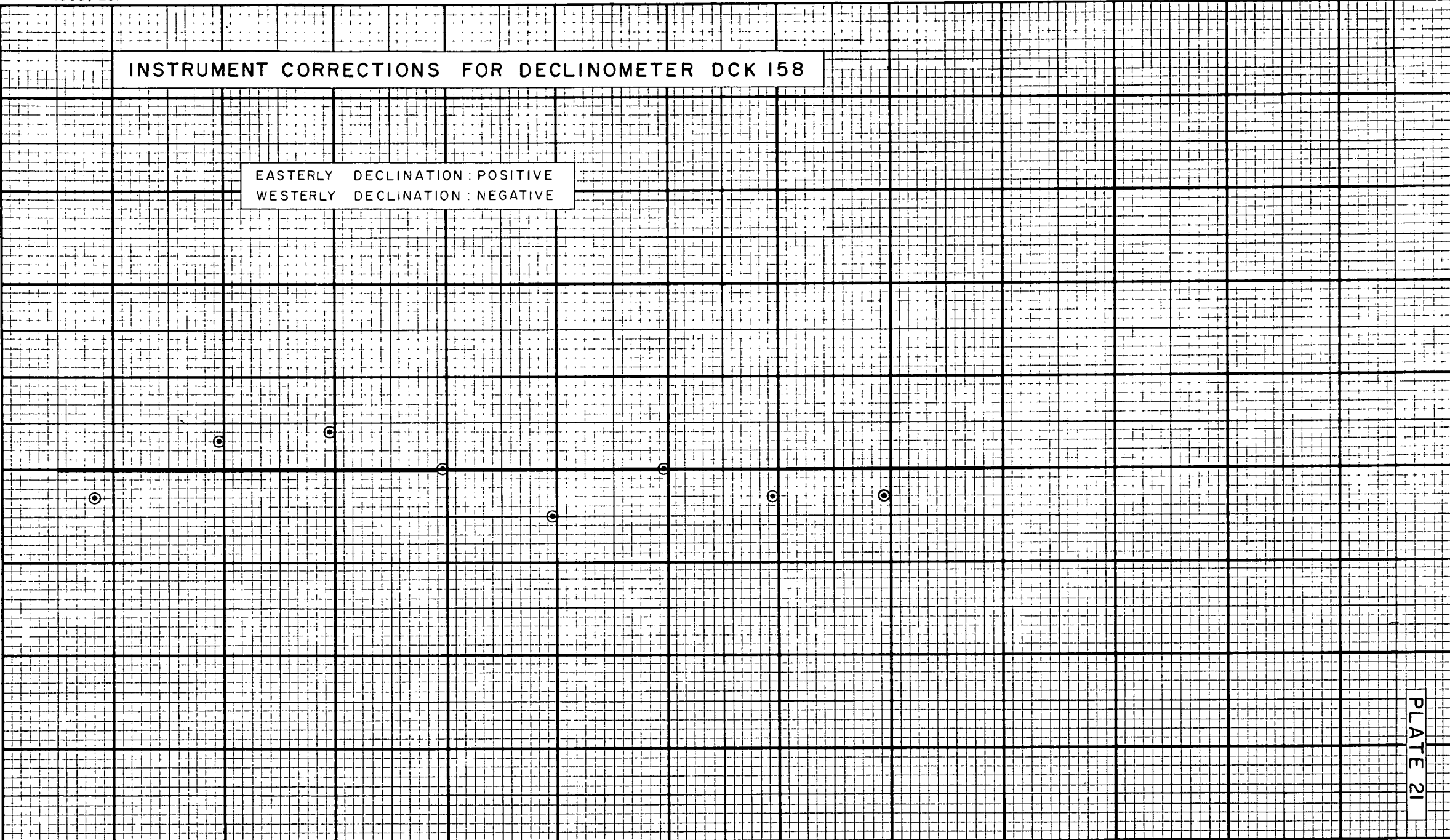
INSTRUMENT CORRECTIONS FOR QHM's 177, 178 & 179 (DECLINATION)



INSTRUMENT CORRECTIONS FOR DECLINOMETER DCK 158

EASTERLY DECLINATION : POSITIVE
WESTERLY DECLINATION : NEGATIVE

MINUTES
+ 1
0
- 1



1966/207

INSTRUMENT CORRECTIONS FOR CIW 28 (DECLINATION)

MINUTES
+3
+2
+1
0
-1
-2

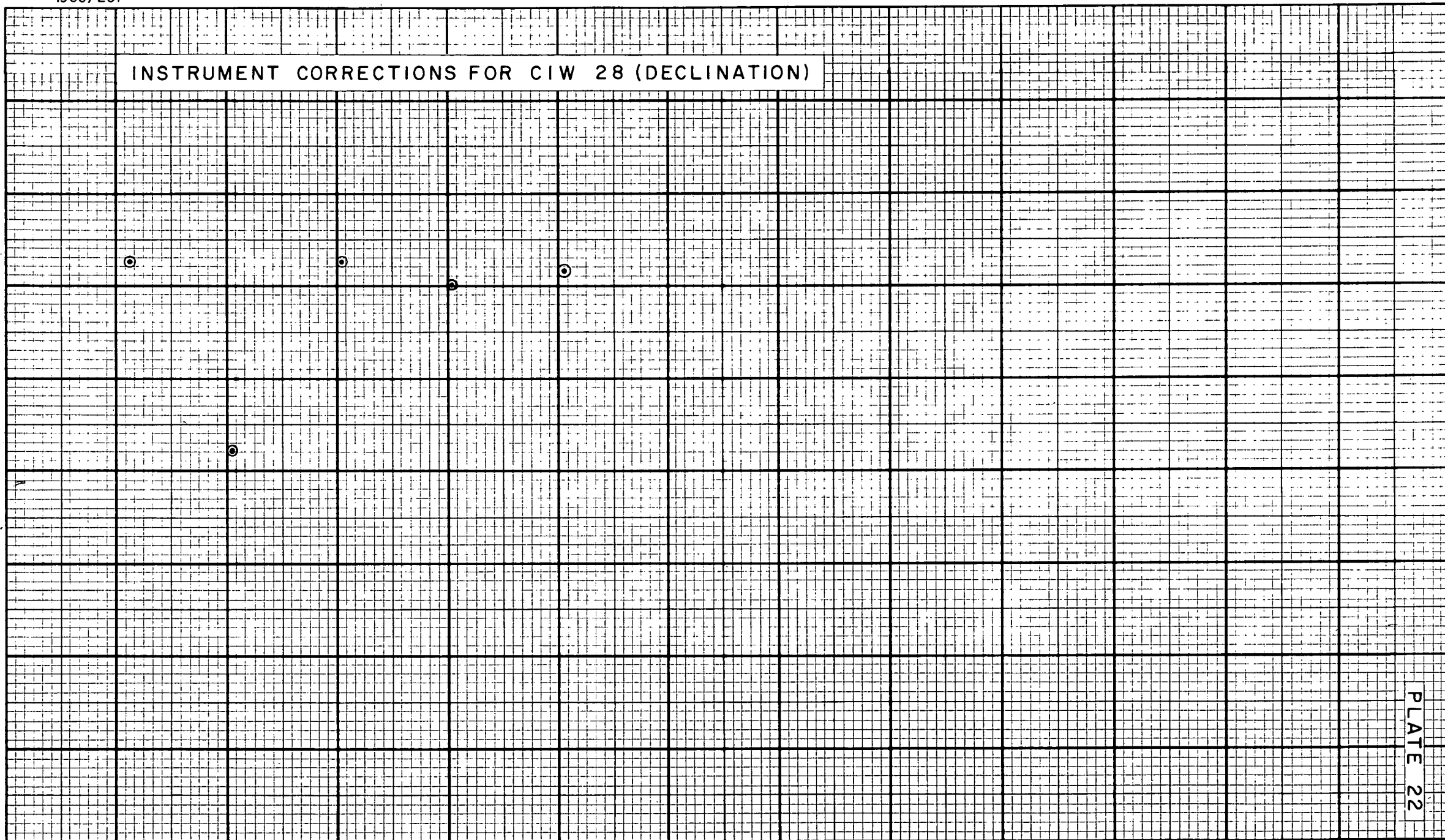


PLATE 22

1959

1960

1961

1962

1963

G 82/2 - 35

INSTRUMENT CORRECTIONS FOR BMZ 62

+ 10
0
- 10
- 20
GAMMAS

Adopted correction

□ Proton Magnetometer observations

PLATE 23

1955

1956

1957

1958

1959

1960

1961

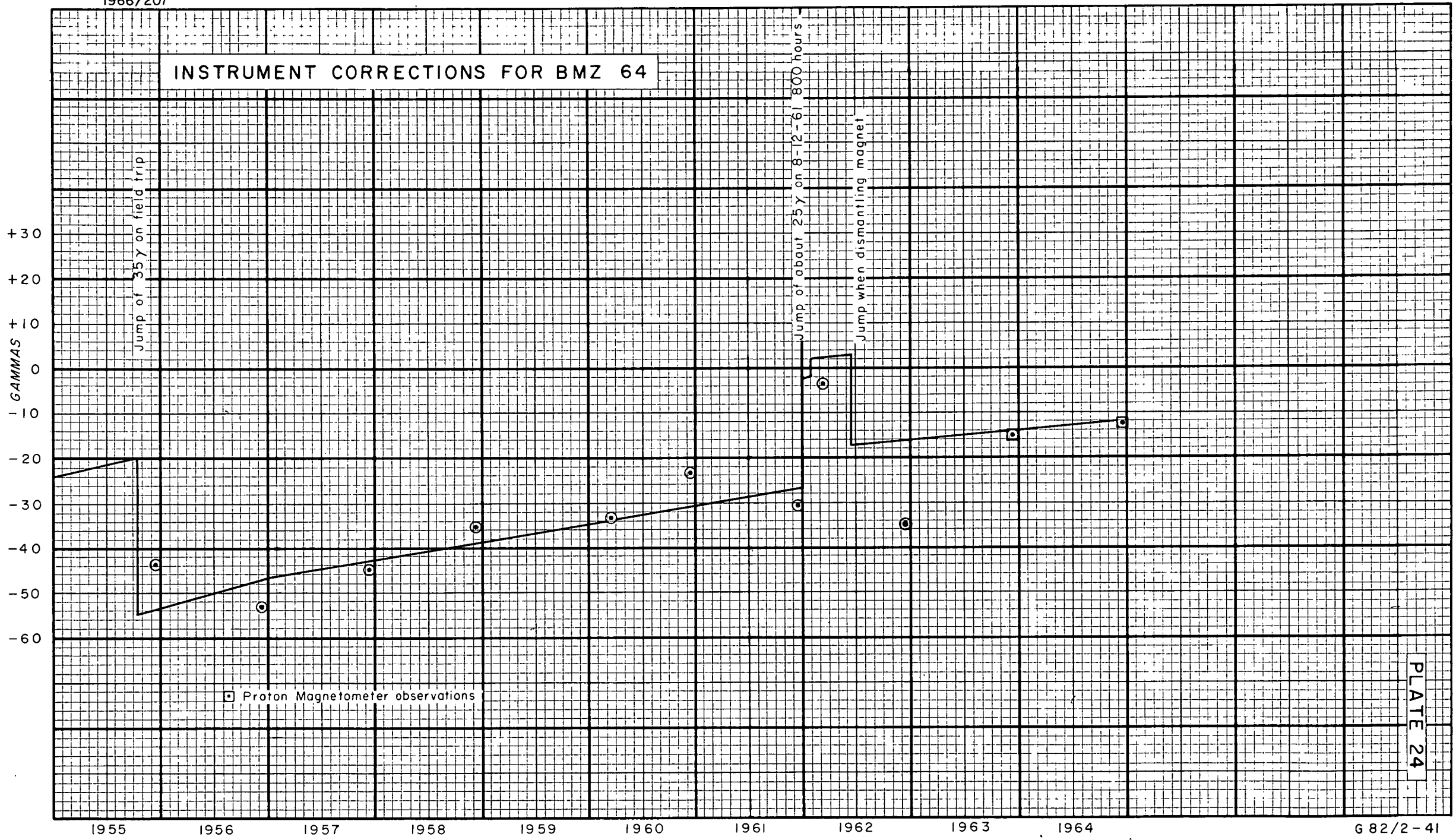
1962

1963

1964

G 82/2-38

INSTRUMENT CORRECTIONS FOR BMZ 64



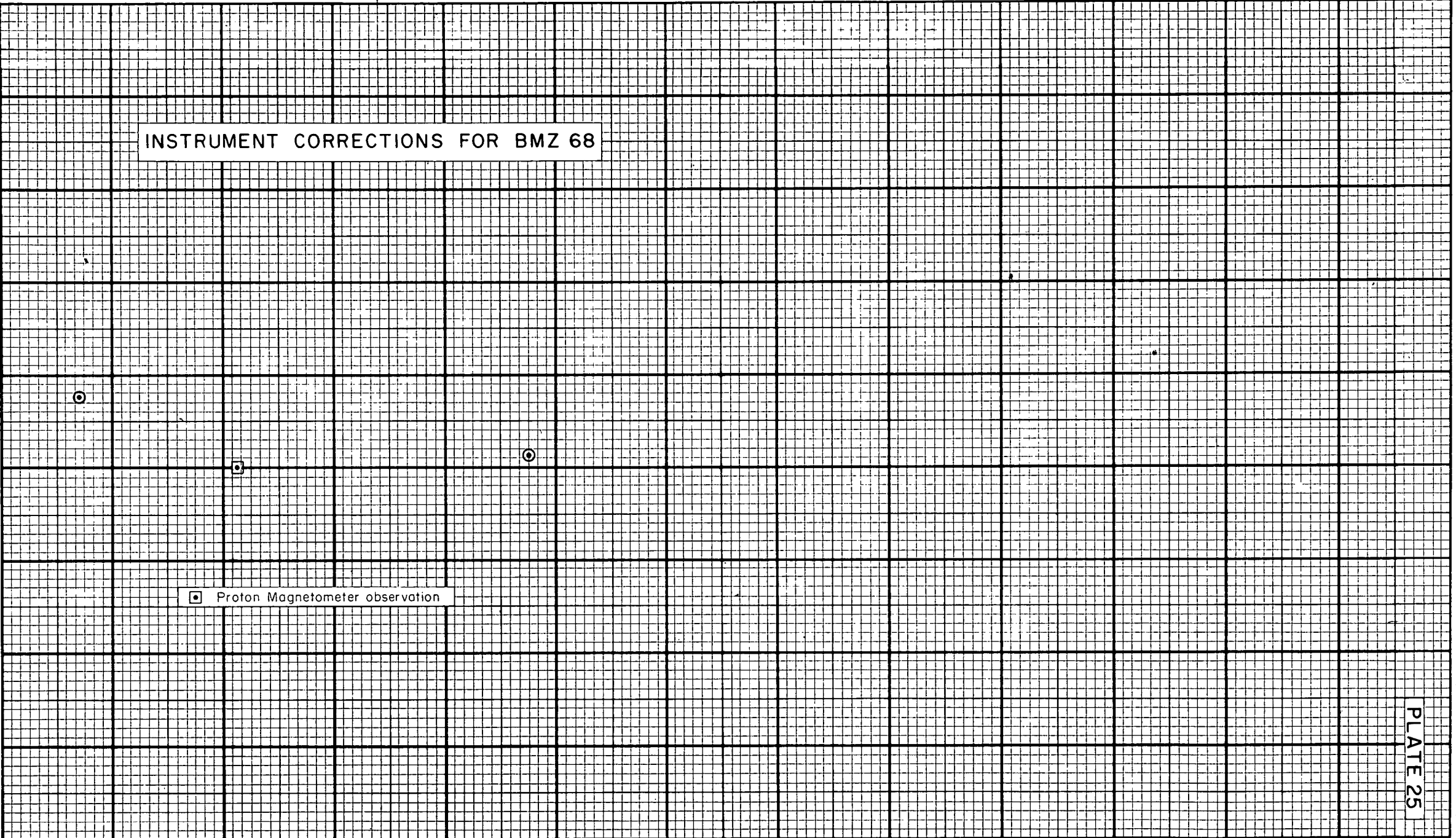
INSTRUMENT CORRECTIONS FOR BMZ 68

□ Proton Magnetometer observation

GAMMAS

+20
+10
0

1960 1961 1962 1963 1964



1966/207

INSTRUMENT CORRECTIONS FOR BMZ 115

GAMMAS
+50
+40
+30
+20
+10
0
-10
-20

1955

1956

1957

1958

1959

1960

1961

1962

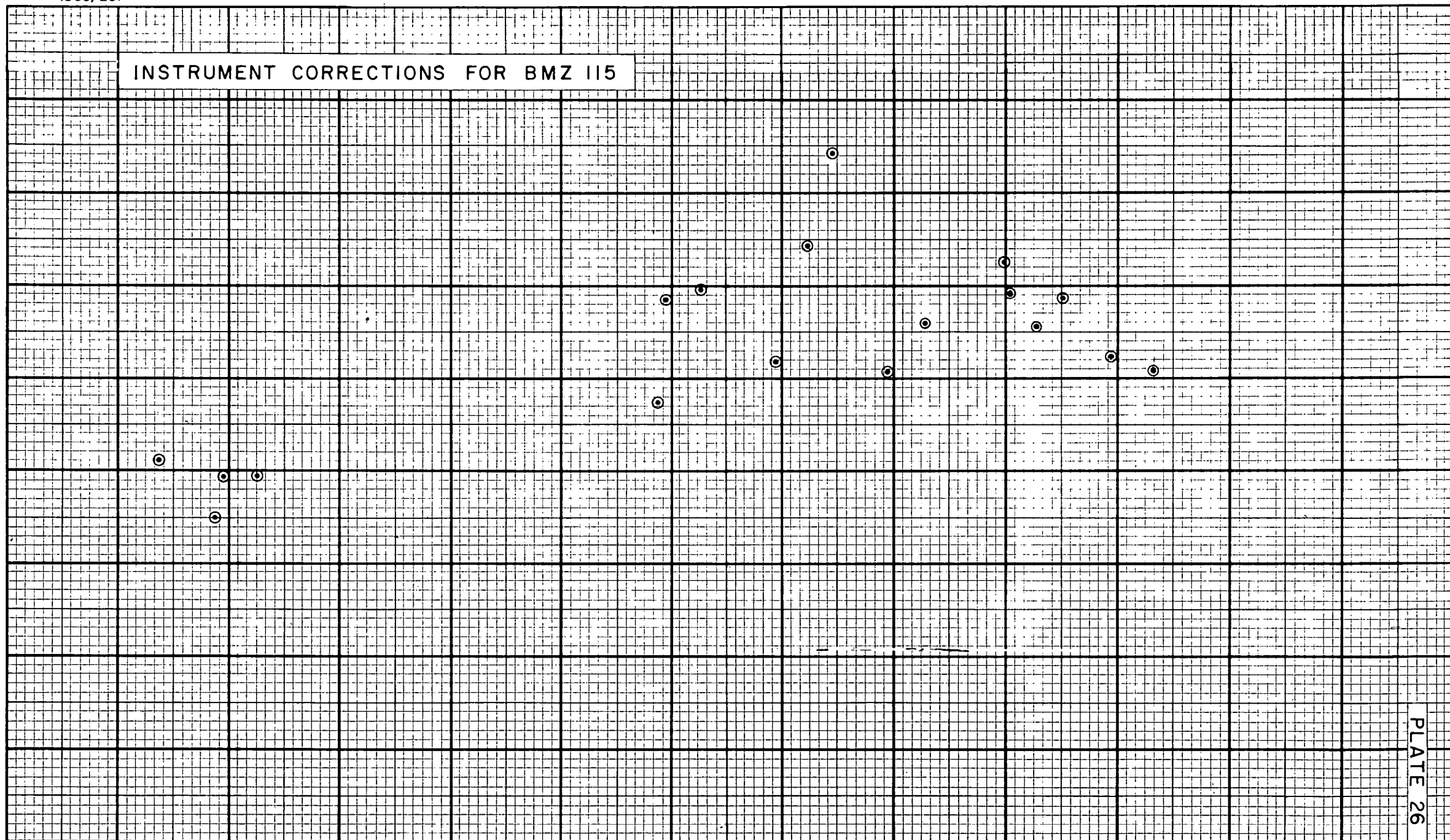
1963

1964

1965

PLATE 26

G 82/2-39



1966/207

INSTRUMENT CORRECTIONS FOR BMZ 119

GAMMAS

+60
+50
+40
+30
+20

□ Proton Magnetometer observations

Adopted correction

PLATE 27

1955

1956

1957

1958

1959

1960

1961

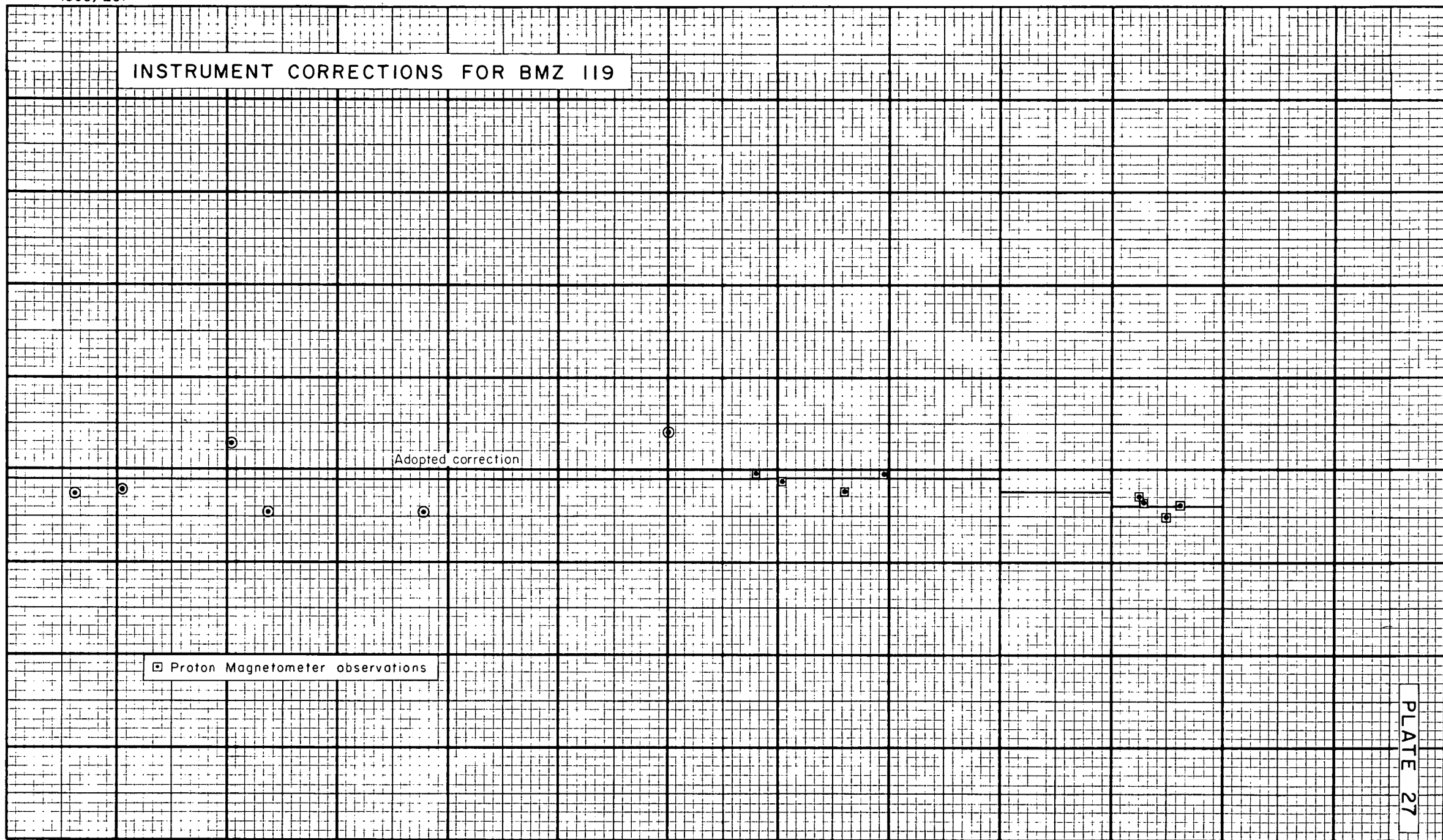
1962

1963

1964

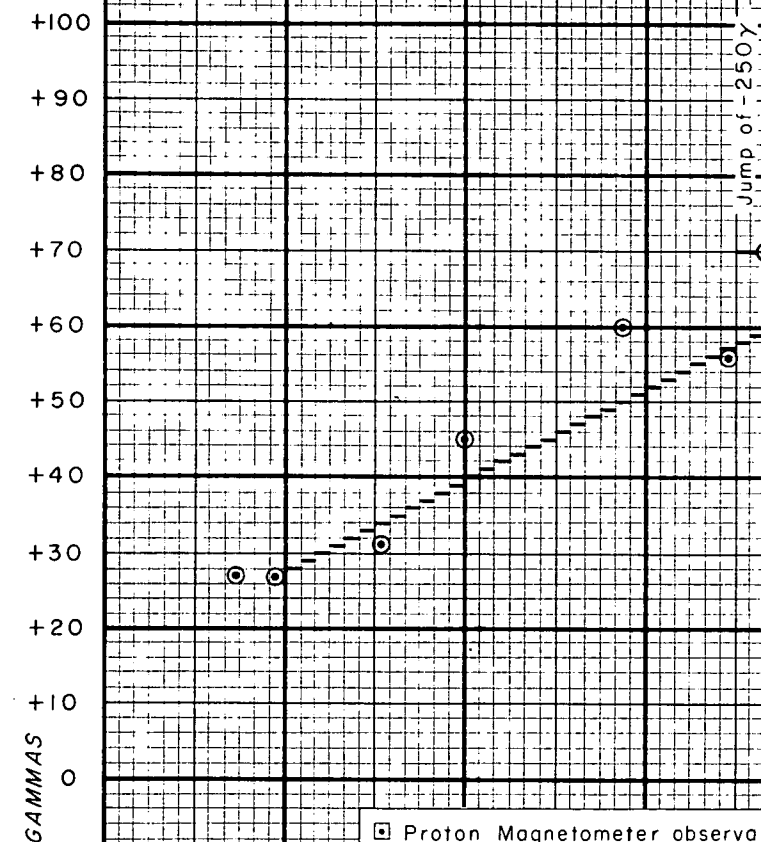
1965

G 82/2-42



1966/207

INSTRUMENT CORRECTIONS FOR BMZ 120



□ Proton Magnetometer observations

1966/207

INSTRUMENT CORRECTIONS FOR BMZ 121

+30
+20
+10
GAMMAS
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100

19 55

1956

1957

1958

1959

1960

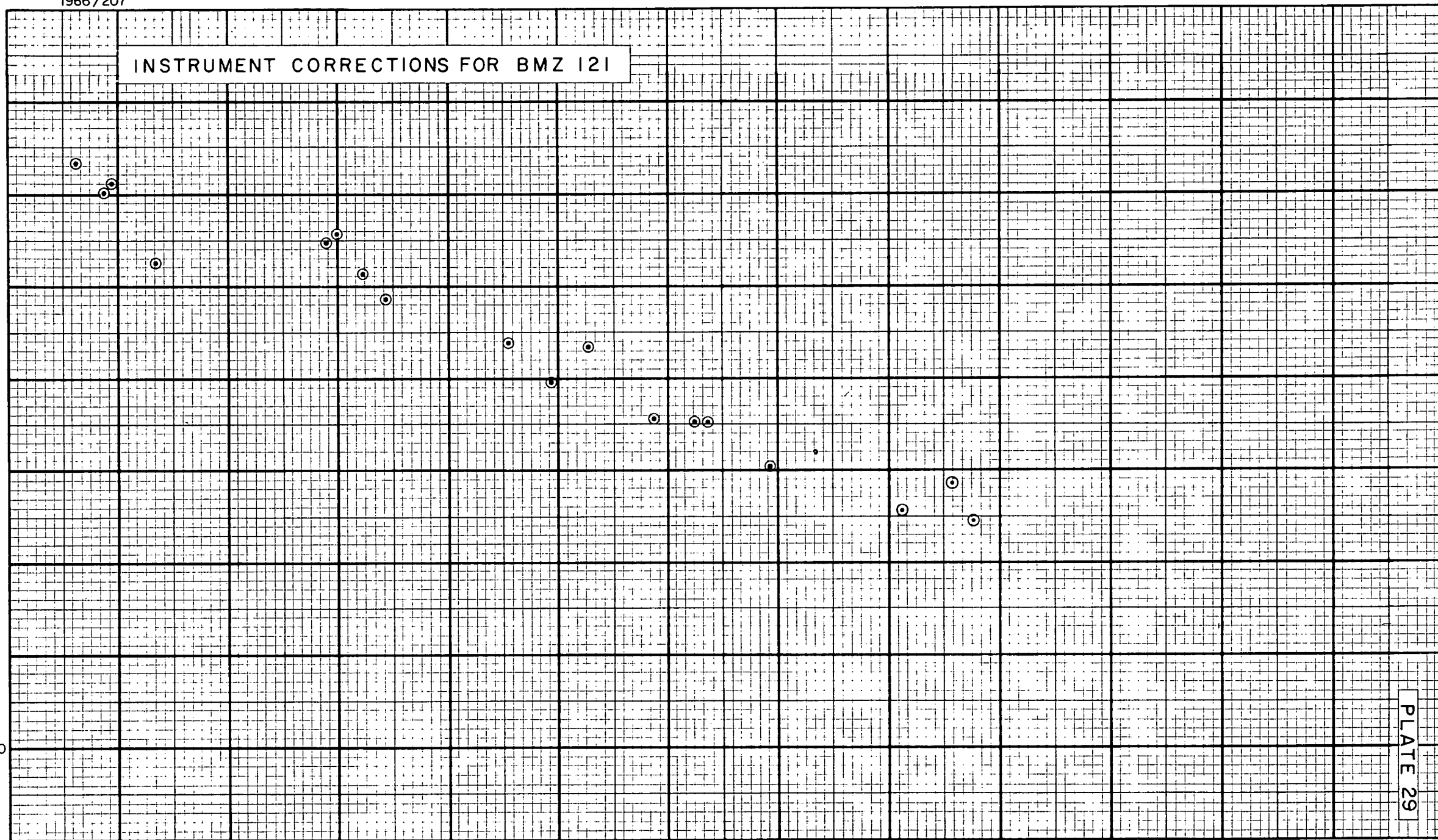
1961

1962

1963

PLATE 29

G 82/2-44



1966/207

INSTRUMENT CORRECTIONS FOR BMZ 211

GAMMAS

+210

+200

+190

+180

+170

+160

+150

+140

+130

+10

0

-10

GAMMAS

Jump of ~46γ on 12-6-62

PLATE 30

1958

1959

1960

1961

1962

1963

1964

1965

G 82/2-43

1966/207

INSTRUMENT CORRECTIONS FOR BMZ 221

GAMMAS
+20
+10
0
-10
-20
-30

1959

1960

1961

1962

1963

1964

1965

PLATE 31

1966 / 207

INSTRUMENT CORRECTIONS FOR BMZ 236

+10

0

-10

-20

Adopted correction

INSTRUMENT CORRECTIONS FOR CIW 28

+10

0

-10

-20

-30

-40

-50

USCGS adopted correction

PLATE 32

G 82 / 2 - 34