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# The East Line of Montana

PRESENTED BY: AARON HUMMERT, PLS, CFEDS  
2023 SDSPLS CONFERENCE  
SIOUX FALLS, SOUTH DAKOTA

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# Background Information

- Surveying on the state line for oil well locations
- Became curious about the geographic location
- Needed an idea for a class project and decided to study this topic

# Outline

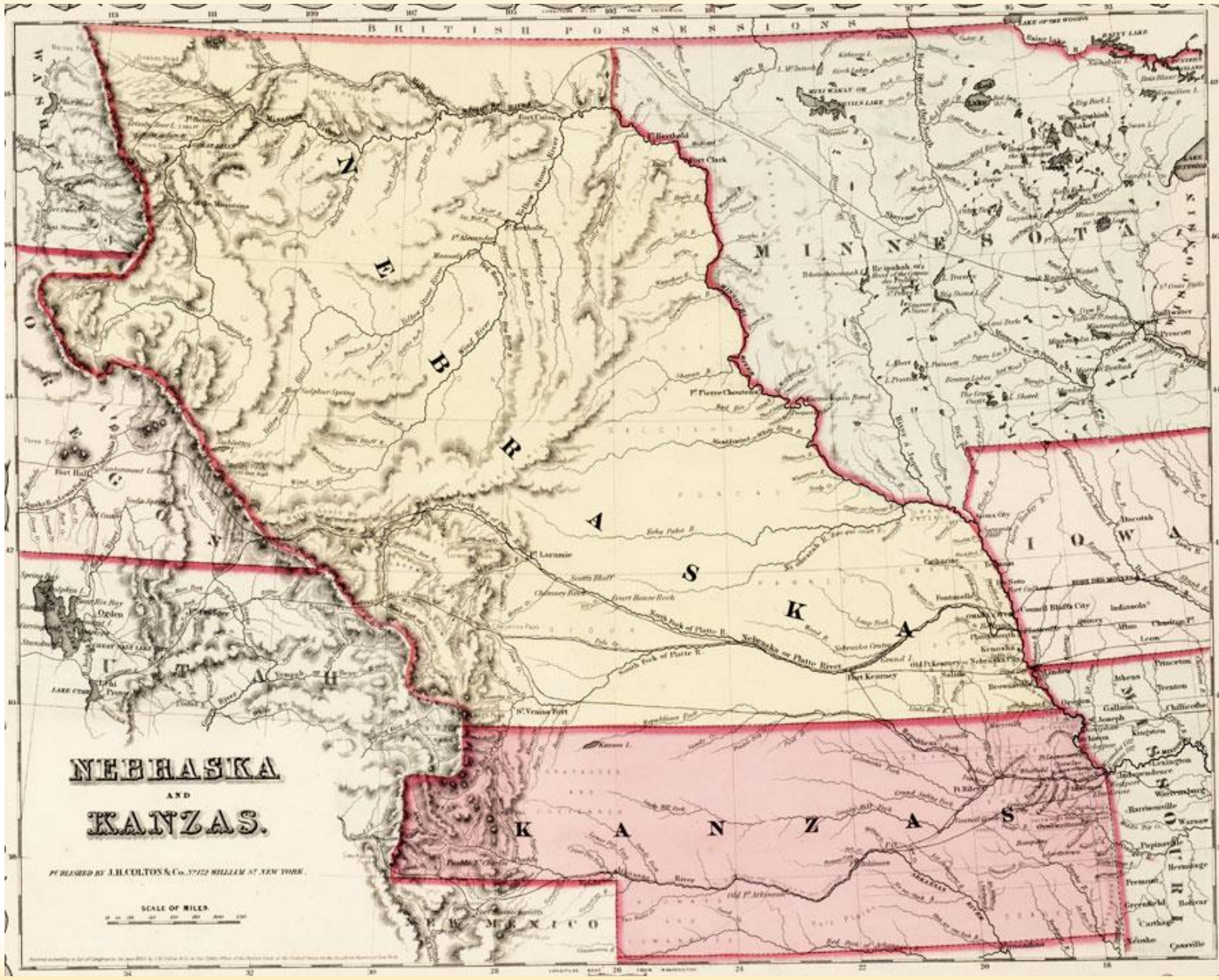
- Legislative history that created the line
- Events leading up to the survey
- History of longitude determination
- Determination of longitude at Mingusville
- Survey of the line
- Resurveys of the line
- Analysis of precision achieved

# Legislative History of the Territorial Line

- Multiple territorial boundaries
- 1803-1859: Unorganized Indian Territory
- 1859: Nebraska Territory
- 1863: The Dakota Territory was created
  - Present day Montana is located both in the Dakota and Idaho Territories
- 1864: The Montana Territory was created



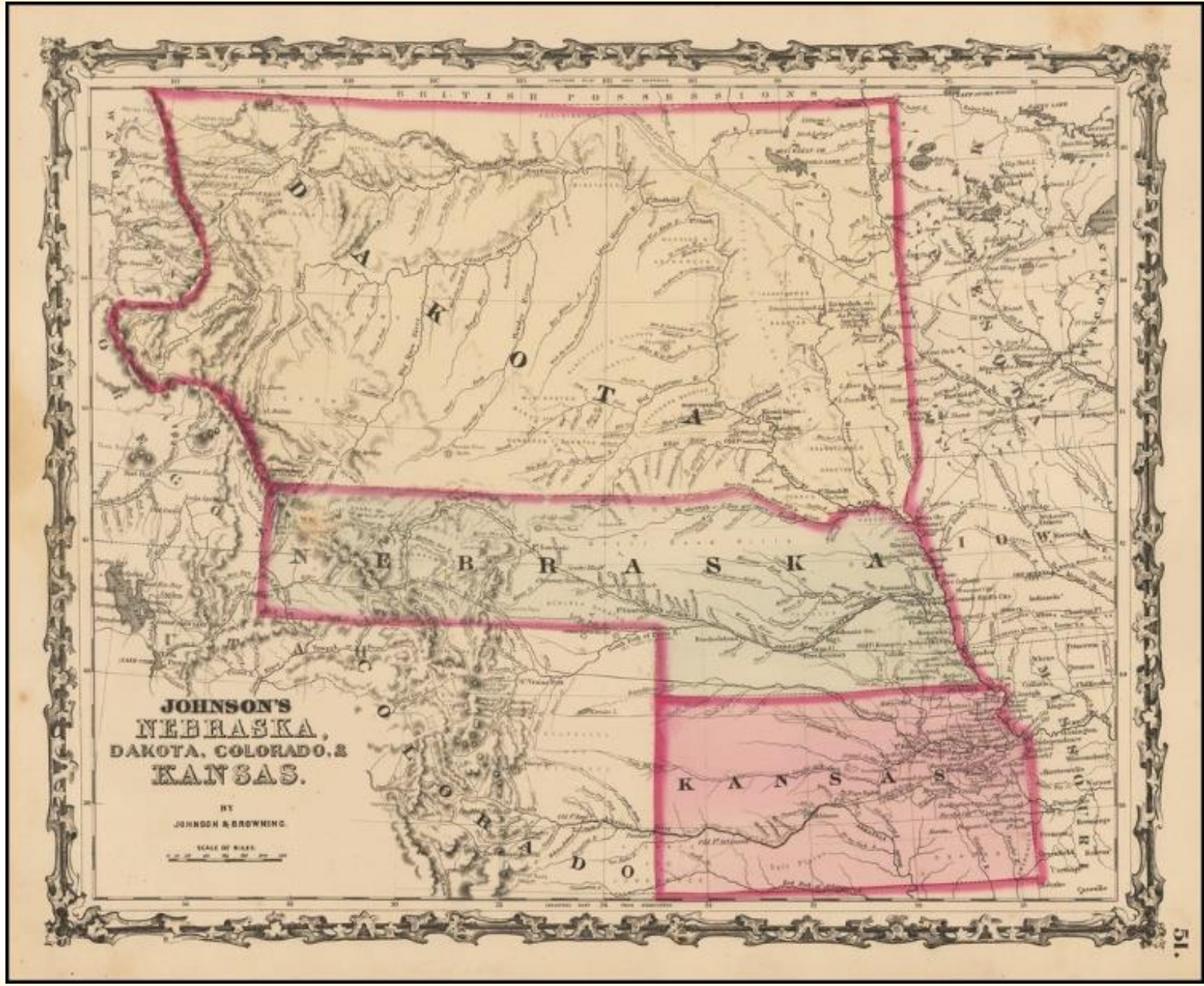
**TERRITORY OF LOUISIANA 1803-1818**  
LOUISIANA PURCHASE TERRITORY  
ceded by FRANCE to the UNITED STATES by  
treaty of April 30, 1803, as asserted and  
maintained by the American Government



**NEBRASKA  
AND  
KANSAS.**

PUBLISHED BY A.H. COLTON & Co. 37 1/2 WILLIAM ST. NEW YORK.

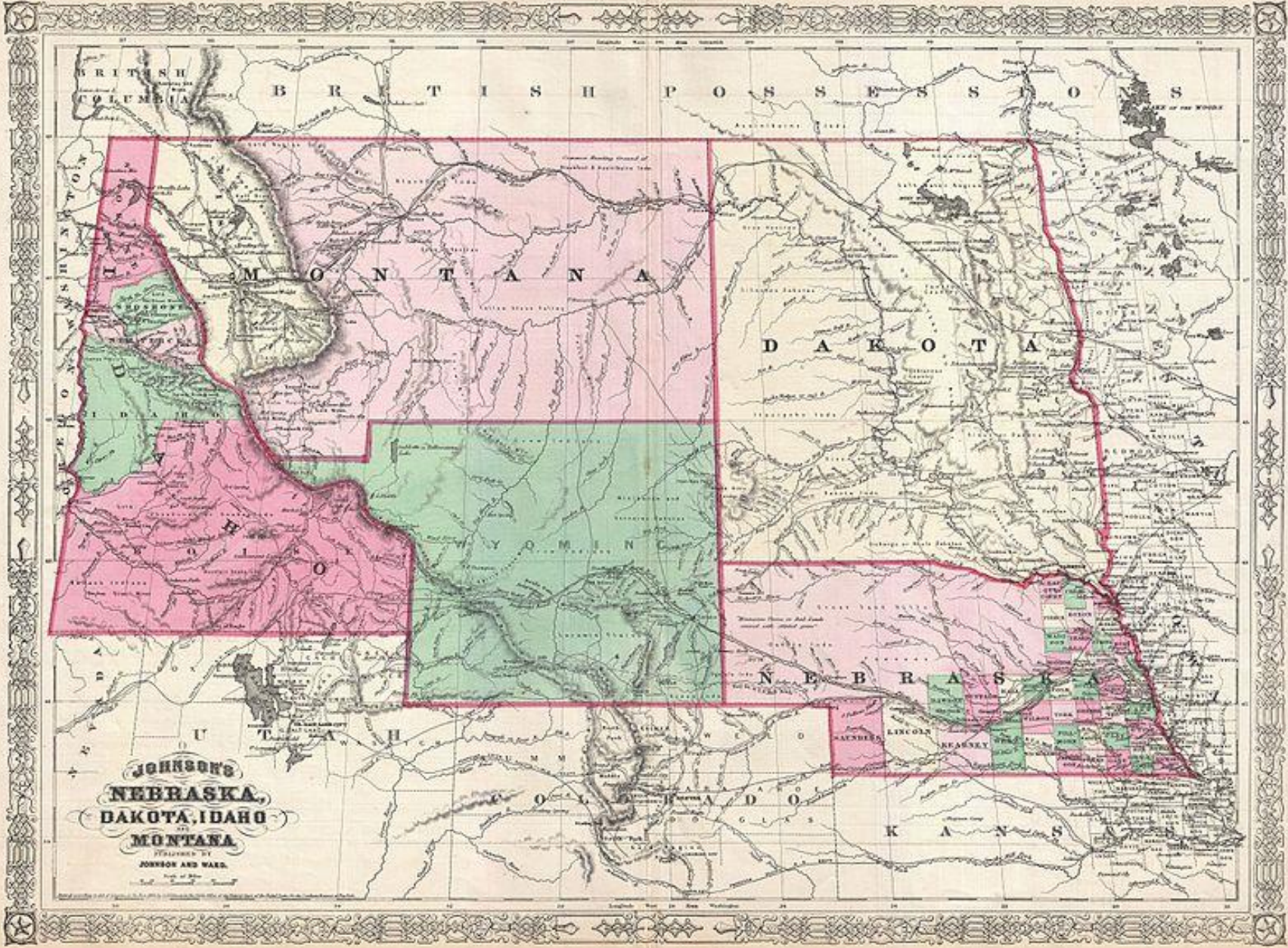
SCALE OF MILES  
0 10 20 30 40 50 60 70 80 90 100



**JOHNSON'S  
NEBRASKA,  
DAKOTA, COLORADO, &  
KANSAS.**

BY  
JOHNSON & BROWNING

SCALE OF MILES  
0 10 20 30 40 50



BRITISH COLUMBIA BRITISH POSSESSIONS

MONTANA

DAKOTA

IDAHO

NEBRASKA

**JOHNSON'S**  
**NEBRASKA,**  
**DAKOTA, IDAHO**  
**and**  
**MONTANA**  
 Prepared by  
**JOHNSON AND WARD.**

UTAH ARIZONA COLORADO KANSAS



# Organic Act of the Territory of Montana

- Approved May 26, 1864, 13 Stat. 85
- Organic Act – a congressional act which institutes a territory or an agency to manage specific federal lands

# Organic Act of the Territory of Montana

- Section 1 – Establishes the boundaries
  - POB is the intersection of 27 degrees west of Washington and 45 degrees north
  - Proceeds clockwise around the territory
  - Bounds to the “boundary line of the British Possessions”
  - “Thence eastward along said boundary to the 27<sup>th</sup> degree west of Washington”
  - “Thence southward along said 27<sup>th</sup> degree of longitude to the place of beginning”

# Organic Act of the Territory of Montana

“The same is hereby created into the temporary government by the name of the territory of Montana...”

# Organic Act of the Territory of Montana

- Section 1 – Establishes the boundaries
  - “Nothing in this act contained shall be construed to impair the rights of person or property now pertaining to the Indians in said territory . . . or to include any territory which . . . is not . . . included within the territorial limits or jurisdiction of any state or territory”
  - “All such territory shall be excepted out of the boundaries, and constitute no part of the territory of Montana”

# Organic Act of the Territory of Montana

- Additional information about the Act:
  - Establishes the framework of the territorial government and the electorate
  - Sec. 6 - “. . . no law shall be passed interfering with the disposal of the soil; no tax shall be imposed upon the property of the United States . . .”
  - Sec. 9 – created the territorial court system

# Organic Act of the Territory of Montana

- Additional information about the Act:
  - Sec. 10 establishes the office of the U.S. Attorney, the U.S. Marshall, and the *Surveyor General*, all to be appointed by the President of the United States.
  - Sec. 10 also provides that the Surveyor General's "*duties, powers, obligations, responsibilities, compensation, and allowances for clerk hire, office rent, fuel, and incidental expenses, shall be the same as those of the surveyor general of New Mexico...*"

# Organic Act of the Territory of Montana

- Additional information about the Act:
  - Sec. 14: *“When the lands in said territory shall be surveyed . . . sections numbered **sixteen and thirty-six** in each township . . . shall be . . . reserved for the purpose of being applied to schools in said territory, and in the states and territories hereafter to be erected out of the same.”*

# Organic Act of the Territory of Montana

- Additional information about the Act:
  - Expressly prohibited slavery
    - The organic act took place during the Civil War
    - Big political push to settle the territories with individuals aligned with the Union Cause



# The Survey of the Boundary – Pre-survey

- The Annual Report of the Commissioner of the General Land Office of 1884 stated:

## *Boundary Between Dakota and Montana*

*“The early extension of the public surveys in Dakota and Montana, particularly within the limits of the Northern Pacific Railroad land grant, render the establishment of the boundary between these Territories a necessity, and I recommend an appropriation for the purpose.”*

-N. C. McFarland, Commissioner

# The Survey of the Boundary – Pre-survey

Sean M. Kammer, “No Trespassing’: Railroad Land Grants, The Right Of Exclusion, And The Origins Of Federal Forest Conservation”:

“... Congress expected that railroad companies would file selection lists, and the appropriate lands would be patented to the railroad companies to be sold to the general public to great benefit. ... Both the construction of railways and the subsequent patenting of lands were delayed for decades. ... Further, despite its construction being gradual, it had patented less than a million acres of its estimated forty-seven million acre grant by that time. While this was probably at least partly due to railroads delaying their applications for lands so as to avoid paying taxes, it was also due to the GLO being overworked.”

# The Survey of the Boundary – Pre-survey

- Cost estimate per 1884 Annual Report:
  - Estimated at 280 miles and \$8400

*Surveying and remarking of boundary lines between state and territories and survey of the boundaries of the Yellowstone Park.*

For the survey of the boundary line between the territories of Dakota and Montana, estimated at 280 miles (submitted) .  
For the remarking of the boundary line between the state of Colorado and the territory of Utah, estimated at 210 miles (submitted) .....  
For the survey of the boundaries of the Yellowstone Park, in the territories of Wyoming, Idaho, and Montana, estimated at 250 miles (submitted) .....

\$8,400 00

6,300 00

7,500 00

22,200 00

# The Survey of the Boundary – Pre-survey

- Cost estimate per 1884 Annual Report:
  - Note below estimate

**NOTE.—**The importance of these boundary surveys arises from the fact of the pressing necessity of defining the closing limits of the public-lands surveys in the territories of Dakota and Montana, particularly within the limits of the Northern Pacific Railroad Company's land grant, the

## The Survey of the Boundary – Pre-survey

- The 1884 Surveyor General reports for both Montana and Dakota are silent about the survey of the territorial boundary
- The territorial boundary appears to have been handled at the Federal level

# The Survey of the Boundary – Pre-survey

- Contract awarded to Daniel G. Major on June 20<sup>th</sup>, 1885, to survey the line.

# The Survey of the Boundary – Longitude

- Longitude equals time
  - 360 degrees of Longitude = 24 hours
  - Measured by finding local time at an arbitrary meridian, local time at a local meridian, and determining the difference.
  - Throughout history, the determination of local time was relatively simple and precise.
  - The challenge was transferring precise time from the reference meridian to the local meridian.

# The Survey of the Boundary – Longitude

- 2<sup>nd</sup> century B.C. – Hipparchus developed the principle of using time to measure longitude
- 1612 - Galileo proposed a method using the moons of Jupiter as a universal clock
- 1683 – Halley considered finding patterns in the deviations of Earth's magnetism
- 1766 – Maskelyne published an ephemeris using stars and the moon for time – adequate for navigation at sea and widely used for this purpose



# The Survey of the Boundary – Longitude

- Mechanical alternatives were explored
- Conditions at sea made this very challenging
- Finally, in the 1770's, Harrison invented the chronometer
  - Found to be very reliable
  - Hundreds of chronometer voyages were used to determine longitude at the Washington Observatory

# The Survey of the Boundary – Longitude

- Railroads developed through America, so did telegraph lines
- Completion of the Trans-Atlantic telegraph line allowed for communications between the US and Europe
- The telegraph lines were then used for determining precise time
- Telegraph proved to be very helpful in the determination of precise time in remote areas of the U.S.
  - Especially to Major which we shall soon discuss

# The Survey of the Boundary – Longitude

- Basis of Longitude
  - Longitude has been referenced to multiple meridians through time
  - Individual countries would establish their own meridian more so for patriotic purposes
  - Due to Maskelyne's ephemeris, the Greenwich Meridian was used at sea

# The Survey of the Boundary – Longitude

- Longitude in the United States
  - 1804 – the center of the White House was used as the prime meridian
  - 1850 – Congress designated the Observatory at Washington to be the basis of longitude
    - 11 Western States were described in reference to the Washington Meridian during the 60 years it controlled longitude in the US

# The Survey of the Boundary – The Mingusville Observatory

- Major was instructed to establish precise longitude as near as possible to the 27<sup>th</sup> meridian along the Northern Pacific Railroad.
- Mingusville - present-day Wibaux - was selected for the observatory since it was the closest location with a telegraph station

# The Survey of the Boundary – The Mingusville Observatory

- Mingusville consisted of 6 houses
- No structure suitable for an observatory
- A temporary observatory was made using materials from an old hen house
- The observatory was constructed 60 feet from the rail
  - This was as far as they could be from the telegraph line
- No materials available to construct a stand for the transit
- As a last resort, the transit's case was filled with dirt and the transit sat on top

# The Survey of the Boundary – The Mingusville Observatory

- Astronomic observations were made on August 20, 21, 22, 28, 29, 30, September 1, 3, 4, & 5, 1885
- Simultaneous observations were conducted at the Washburn Observatory in Madison, Wisconsin
- Professor Edward S. Holden conducted the observations at Washburn
  - Holden published a paper summarizing his methods and calculations

# The Survey of the Boundary – The Mingusville Observatory

- The field notes state observations were challenging due to the awkward use of the instrument and frequent train traffic hauling cattle
- Major requested to conduct the longitude observations at Fort Buford
- His request was denied and he was not given a reason
- He absolved himself of any error on account of passing trains



## The Survey of the Boundary – The Mingusville Observatory

- *Why was Major not granted his request to perform longitude observations at Fort Buford?*

**Very likely due to the pressures put on the General Land Office to determine the boundary in relation to the Northern Pacific land grant.**

# The Survey of the Boundary – The Mingusville Observatory

- Holden's corresponding paper stated the following:
  - *“He (Major) has not furnished any description of it (the observatory) to me, but I infer that his transit pier was not far from the railway tracks and the observations show very great changes in azimuth which may be due to proximity.”*
  - *“. . . the observations were much disturbed by passing trains on the railway”*
  - *“My opinion is, that Mr. Major's transit instrument was never stable for more than a comparatively short period.”*

# The Survey of the Boundary – The Mingusville Observatory

- Spite the stated issues with the passing trains and the makeshift observatory, Major commented favorably about the weather
- While Major said the weather was conducive, Holden speculated that the weather, “was decidedly unfavorable during the whole series...”

Who knows?

# The Survey of the Boundary – The Mingusville Observatory

- Observations were made using:
  - Transit
  - Chronometer – a very precise stop watch
  - Electric break circuit chronograph
  - Telegraph instruments to communicate between Mingusville and Madison

# The Survey of the Boundary – The Mingusville Observatory

- Chronometer



# The Survey of the Boundary – The Mingusville Observatory

- Chronograph



# The Survey of the Boundary – The Mingusville Observatory

- Redundant measurements were made
  - Azimuth – to determine the local meridian
  - Local Time – to determine the difference in time between Mingusville and Madison
  - Time transmitted by telegraph – to correct the chronometer at Mingusville

# The Survey of the Boundary – The Mingusville Observatory

- Major sighted on 12 time stars
- The time stars picked were likely stars that would've been visible at both Mingusville and Madison
- Holden used the *Berliner Jahrbuch Catalogue* for the ephemeris
- Major used both the *Berliner Jahrbuch Catalogue* and the *American Ephemeris*
- Time was averaged to yield a “mean epoch”



# The Survey of the Boundary – The Mingusville Observatory

- Time corrections were sent through telegraph approximately 10 minutes a night
  - This process was referred to as “collimation”
  - A signal was sent from Washburn, as soon as Major received it, he sent it back, the difference in time was split in half
  - Major reported a  $\frac{1}{2}$ -second difference in time
    - This is probable as an 1875 Popular Mechanics article reported that  $\frac{1}{20}$ <sup>th</sup> of a second was achievable

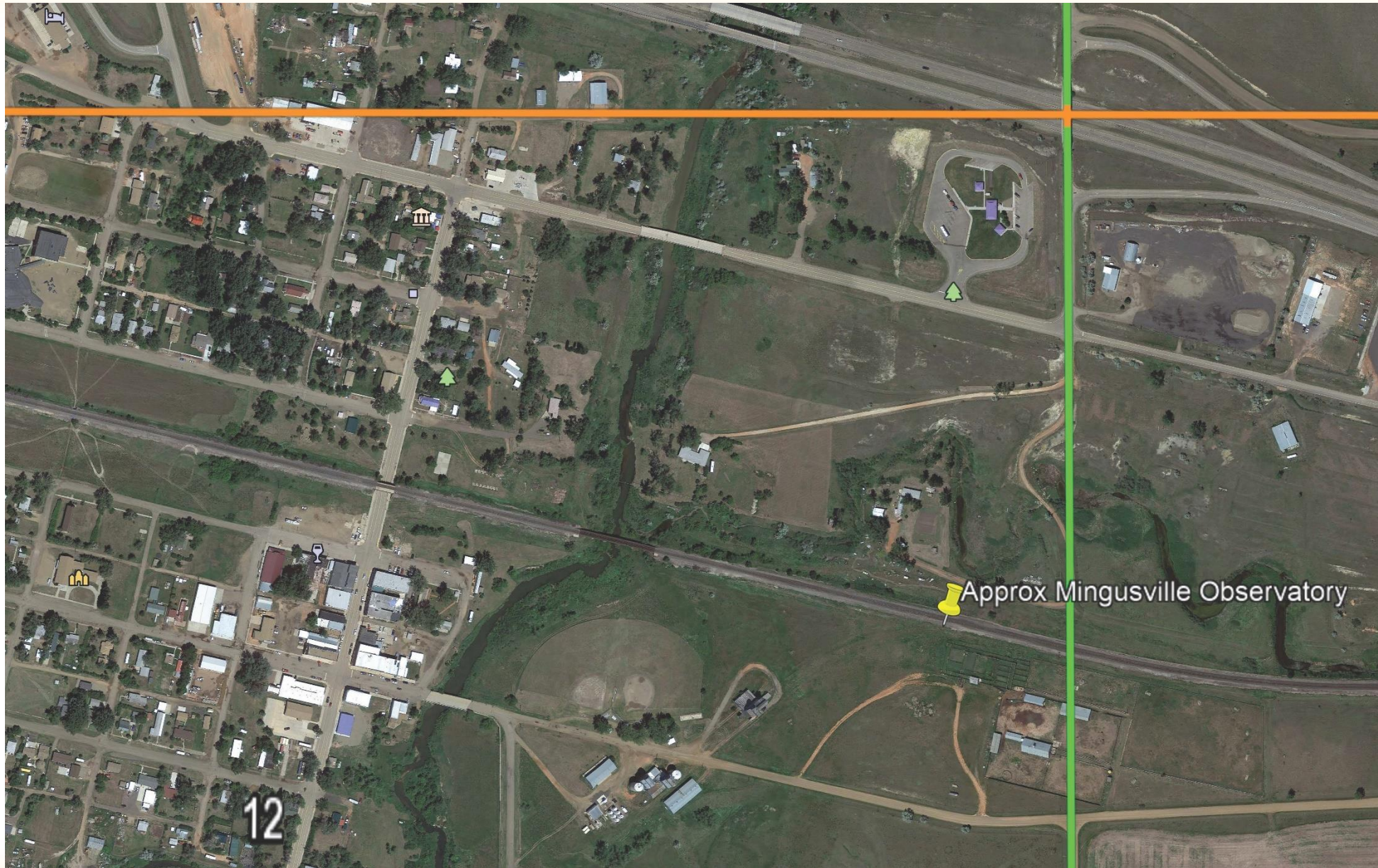
# The Survey of the Boundary – The Mingusville Observatory

## The Final Result

*0 Hours, 59 Minutes, 6.49 seconds west of Washburn*

## In terms of distance

*6 miles, 28 chains, 57 links West of the 27<sup>th</sup> Meridian*



# The Survey of the Boundary – Running the Line

- Major measured east 6 miles, 28 chains, 57 links
- From there, Major headed south to find the NE corner of Wyoming set in 1880
- Multiple observations were made to Polaris as they traversed south
- They found the NE corner of Wyoming to be 70 chains, 68 links west of their determined line
- The SE corner of Montana was established at the intersection of Major's line ran south from Mingusville and a line ran due east from the NE corner of Wyoming

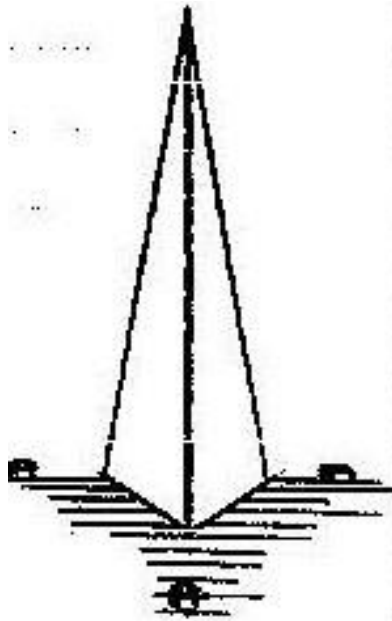
# The Survey of the Boundary – Running the Line



# The Survey of the Boundary – Running the Line

- The SE corner of Montana was constructed – The Initial Monument
  - Three large sandstones and a 30” x 12” x 12” triangular capstone
    - Marked “DAK 27 WL” on east face
    - Marked “WYO 45 LAT” on southwest face
    - Marked “Montana 1885” on the northwest face
    - Marked “IM” on the top of the monument
  - Set three marked stones 20 links E, SW, and NW and dug a pit 30 links south of the initial monument

# The Survey of the Boundary – Running the Line



## Initial Monument.

At this exact intersection of these lines which was on low ground, sloping down to South East and about 1 $\frac{1}{2}$  chains West of small ravine which puts down for a few chains to north and into larger one draining to the East, made excavation 2 feet deep and deposited a quantity of charred wood,

# The Survey of the Boundary – Running the Line

- October 6, 1885 (approx.), they proceeded north
  - Notes kept in like manner to normal GLO notes
  - Monuments and topographic calls were noted as well as the general terrain, vegetation and soil quality
  - Continual astronomic sights were made to verify bearing
  - They monumented a milepost every 80 chains
  - Monuments were marked stones and marked wood posts
  - Used old bones, broken glass, and pits as accessories
  - The notes state that they achieved roughly 5 to 7 miles of line a day
  - Routine checks to a standard chain carried with them



## The Survey of the Boundary – Running the Line

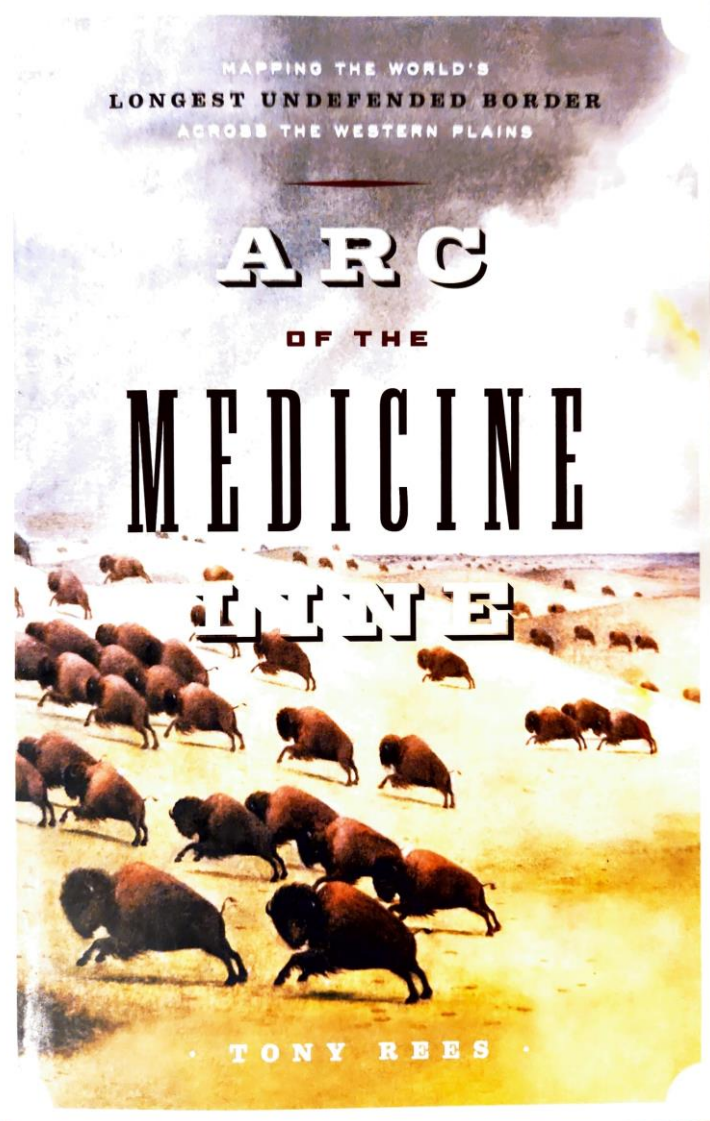
- November 2 – they reached the point due east of the Mingusville Observatory 136 miles, 74.00 chains north of the Initial Monument
- November 16 – they reached the Yellowstone River at MP 194
- November 19 – crossed the Missouri River between MPs 207 and 208
  - They triangulated across both rivers – this was the only two times they reported an alternative measurement procedure

# The Survey of the Boundary – Running the Line

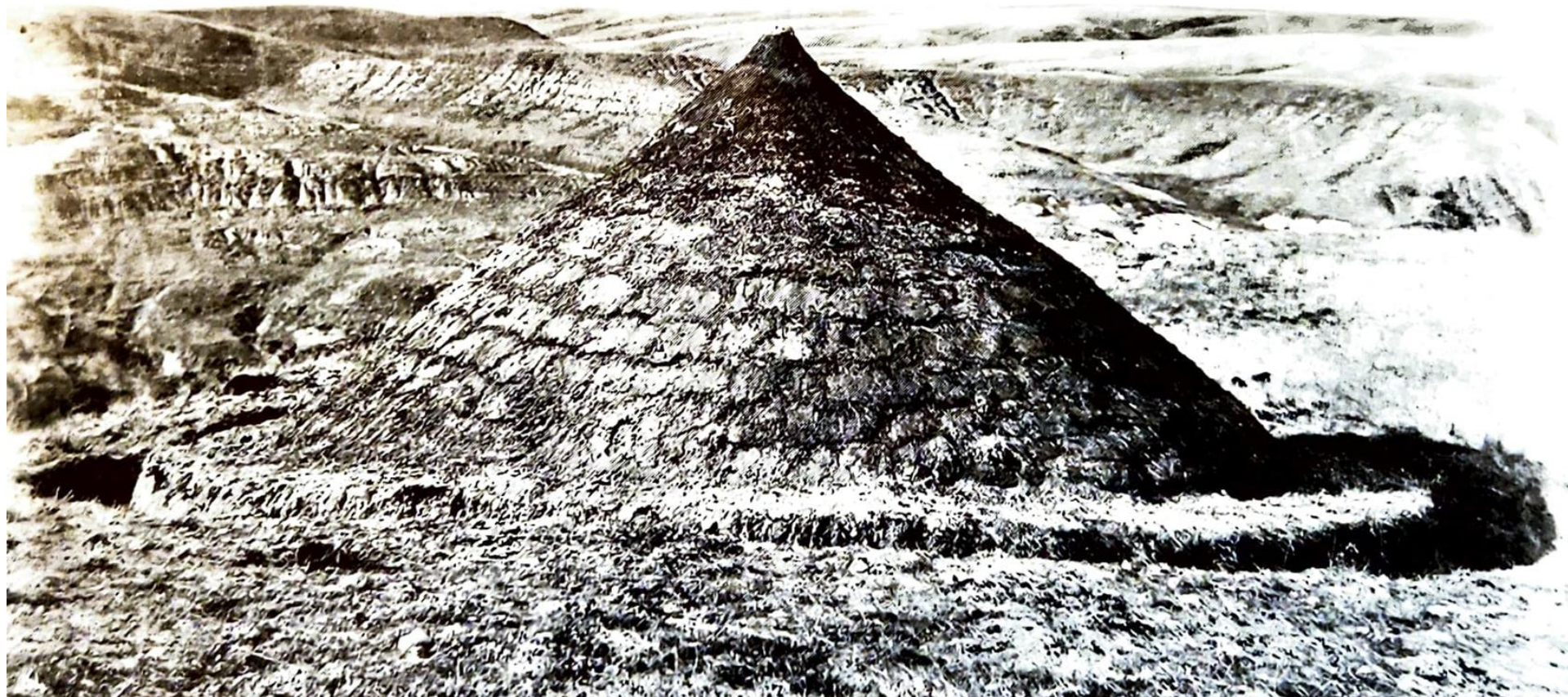
- December 4 – the crew approached the 49<sup>th</sup> parallel
  - the field notes describe the day as “very cold”
  - They measured the theoretical distance of 276 miles, 23 chains
- A blizzard sat in and continued for two days
  - The field notes say the crew “suffered severely”
  - No wood or buffalo chips available to start a fire
  - Temperatures were reported to fall well below zero

## The Survey of the Boundary – Running the Line

- After the blizzard passed, the crew began looking for monuments on the International Line
- Major mentioned that very limited information regarding the survey of the 49<sup>th</sup> parallel was provided
- After searching, the crew began to find Canadian closing corners
- Eventually the crew located mileposts believed to have been established by the Joint Boundary Comm.



Great book on the survey of the International Border!



Packed earth and sod-covered boundary marker west of the Souris River, 1873.



Royal Engineers sappers building a boundary marker near the Milk River, 1874.

# The Survey of the Boundary – Running the Line

- The crew constructed the “terminal monument” at the intersection of the 27<sup>th</sup> meridian and the retraced 49<sup>th</sup> parallel established by the Joint Boundary Comm.
- Constructed from two large stones
  - “DAK 49 L” was scribed in the east face
  - “MON 27 WL” was scribed on the west face
  - “276 27 80” was scribed in the top of the capstone
  - They built a large base of earth and stones, deposited bones and a glass lamp, and dug pits southeast and southwest of the monument

# The Survey of the Boundary – Running the Line

- They located what they believed to be an astronomical point established by the Joint Boundary Commission – “Mid-Coteau”
- The longitude at “Mid-Coteau” was established by a distance measurement from “Pembina” – 312 Miles to the East near Lake of the Woods
- The difference was determined to be 1 mile, 31 chains, 85 links
- They disregarded “Mid-Coteau” figuring it was subject to distance error from having been chained from such a distance to the east



## The Survey of the Boundary – Running the Line

- In the last paragraph of Major's report, he states:

*“I respectfully call attention to the care in chaining this survey.”*

- He concludes by reporting:

*“The theoretical distance from the 45th to 49th parallel is 276 miles, 23 chains. The distance by my chainmen's measurement was 276 miles, 27 chains, and 80 links, being in excess of 4 chains and 80 links.”*

## Resurveys – Peck, 1904

- 1904 - Frank S. Peck, U.S. Surveyor was contracted to resurvey of the north 101 miles of the west boundary of South Dakota
  - Estimated cost was \$10,100
  - The stone to be used is “Sioux Falls Jasper” – supplied from Love and Handley from Sioux Falls, SD
  - The monuments were to be 10” square by 6’ long
  - The letters and figures were to be “Egyptian” text, either 2-1/2” or 1-1/4” high and were to be 1/2” wide x 1/4” deep

## Resurveys – Peck, 1904

- In review of the notes, Peck was able to recover all but one monument between the SE corner of Montana and the NW corner of South Dakota
- MP 63 was the one monument that was not recovered
  - Appears to have fallen in “an unsafe place” per the notes and review of aerial photography
- Several of Peck’s MPs are visible on Google Earth

# Resurveys – Peck, 1904

SE Corner of Montana



# Resurveys – Peck, 1904

SE Corner of Montana



# Resurveys – Peck, 1904

SE Corner of Montana



# Resurveys – Peck, 1904

Milepost 47



# Resurveys – Peck, 1904

Milepost 47

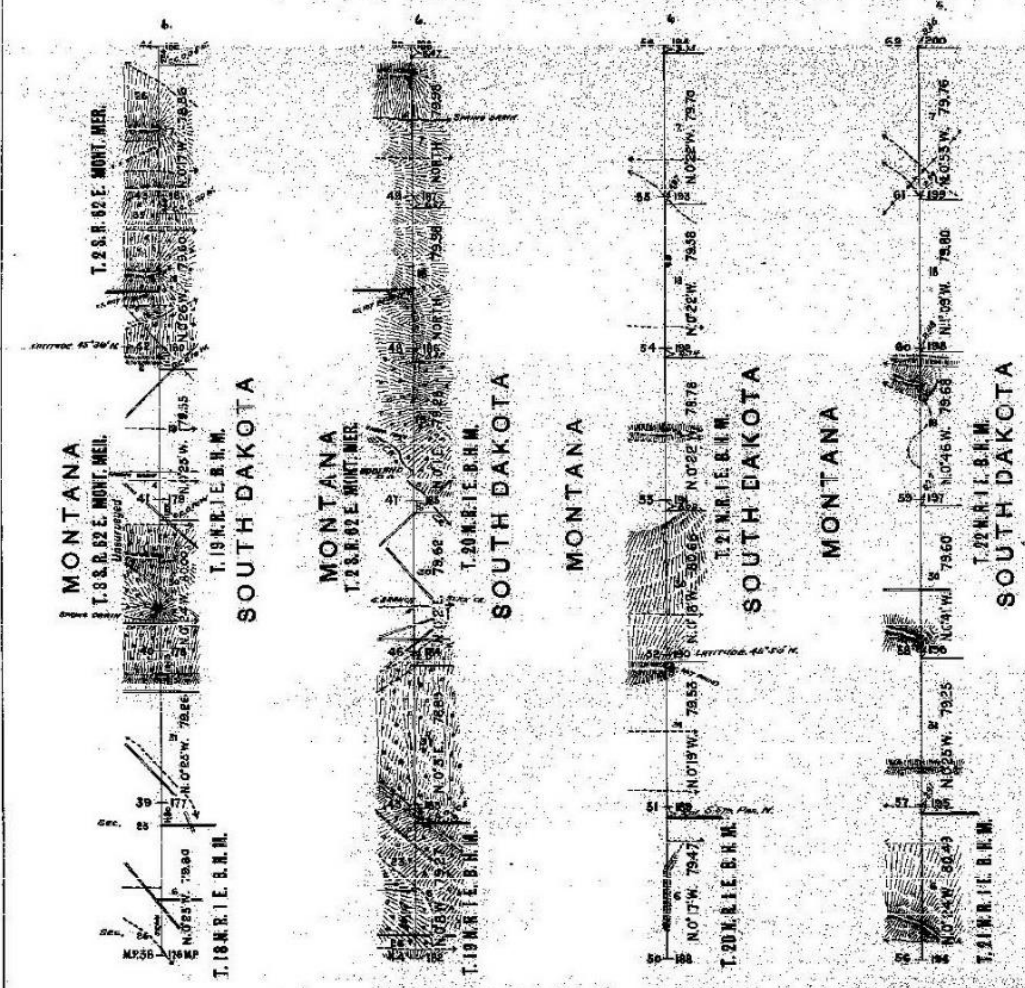




DUPUICITE

SHEET NO. 4

FROM THE 170th MILE POST TO THE 90th MILE POST



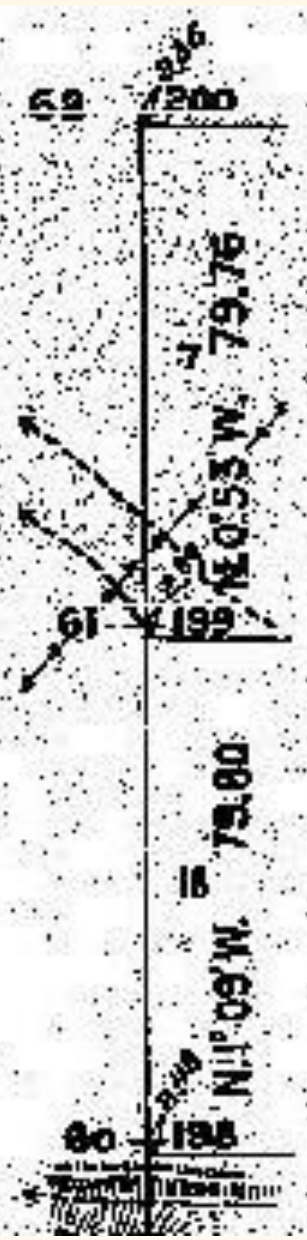
**MAP**  
 OF THE  
**Re-Survey, Re-Marking and Re-Establishment**  
 OF THE  
**North One Hundred and One Miles**  
 OF THE  
**West Boundary of South Dakota**

**FRANK S. PECK,**  
 U. S. Surveyor,  
 Under Contract with the Hon. Commissioners, G. L. O. Dated June 11, 1904,  
 And Special Instructions Dated July 1, 1904.

Surveyed from Oct. 21 to Nov. 3, 1904.

Scale: 40 Chains = 1 Inch.  
 Office of U. S. Surveyor General,  
**RECEIVED**  
 OCT 7 - 1905

Huron, South Dakota.  
*Frank S. Peck*  
 October 11, 1904



# Resurveys – Joint Boundary Commission

- The NE corner of Montana – Monument #583
  - Provided with corner recovery notes by the Joint Boundary Commission
  - Established in 1911
  - Recovered by the Joint Boundary Commission in 1993
  - *“The monument marks the northern terminus of the Montana – North Dakota state line.”*
  - Last year recovered 1995

# Resurveys – Joint Boundary Commission

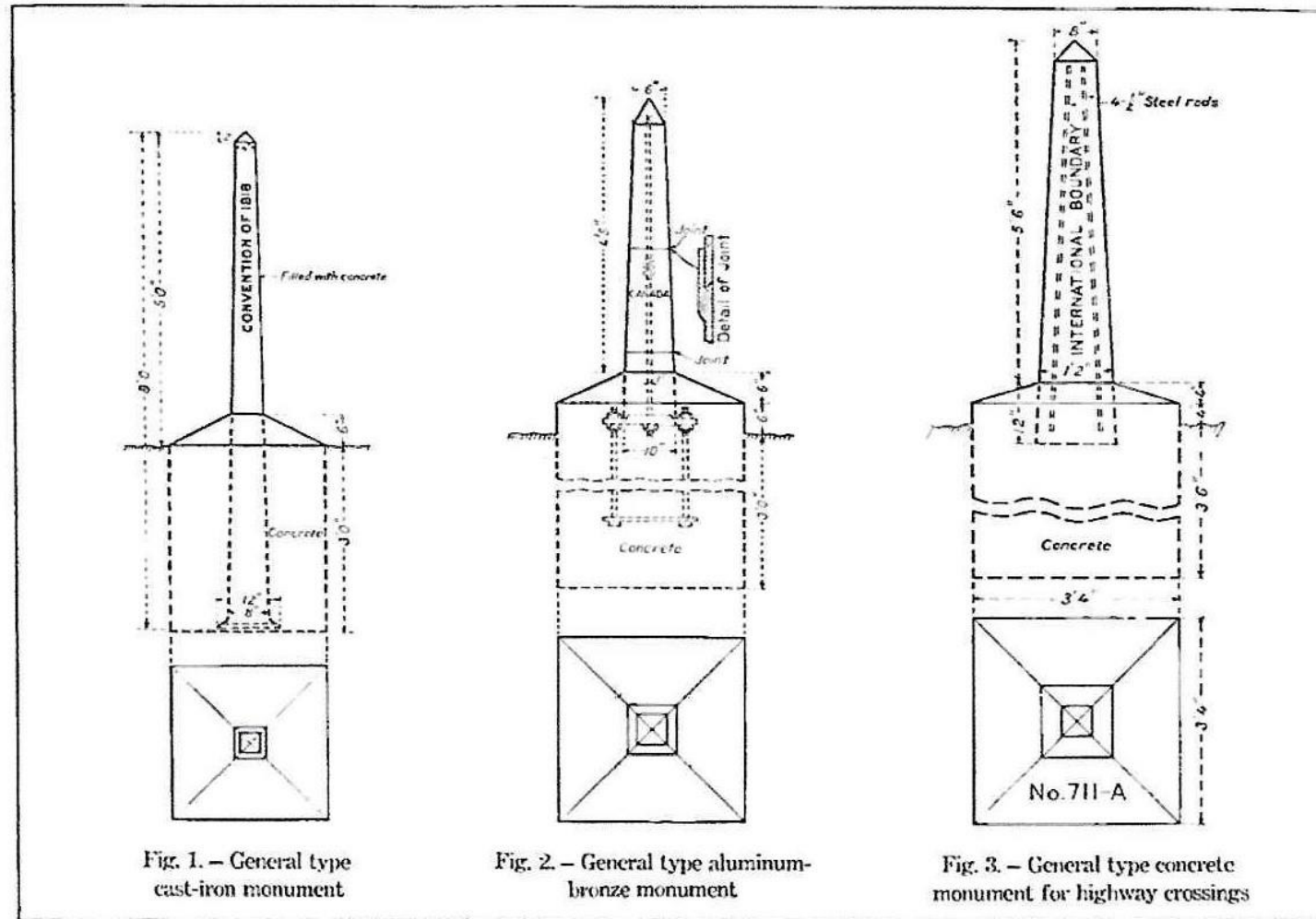


Fig. 1. – General type cast-iron monument

Fig. 2. – General type aluminum-bronze monument

Fig. 3. – General type concrete monument for highway crossings

# Resurveys – Joint Boundary Commission

Milepost along the  
49<sup>th</sup> Parallel – not the  
NE corner of  
Montana, but similar



# Resurveys – Joint Boundary Commission

Milepost along the  
49<sup>th</sup> Parallel – not the  
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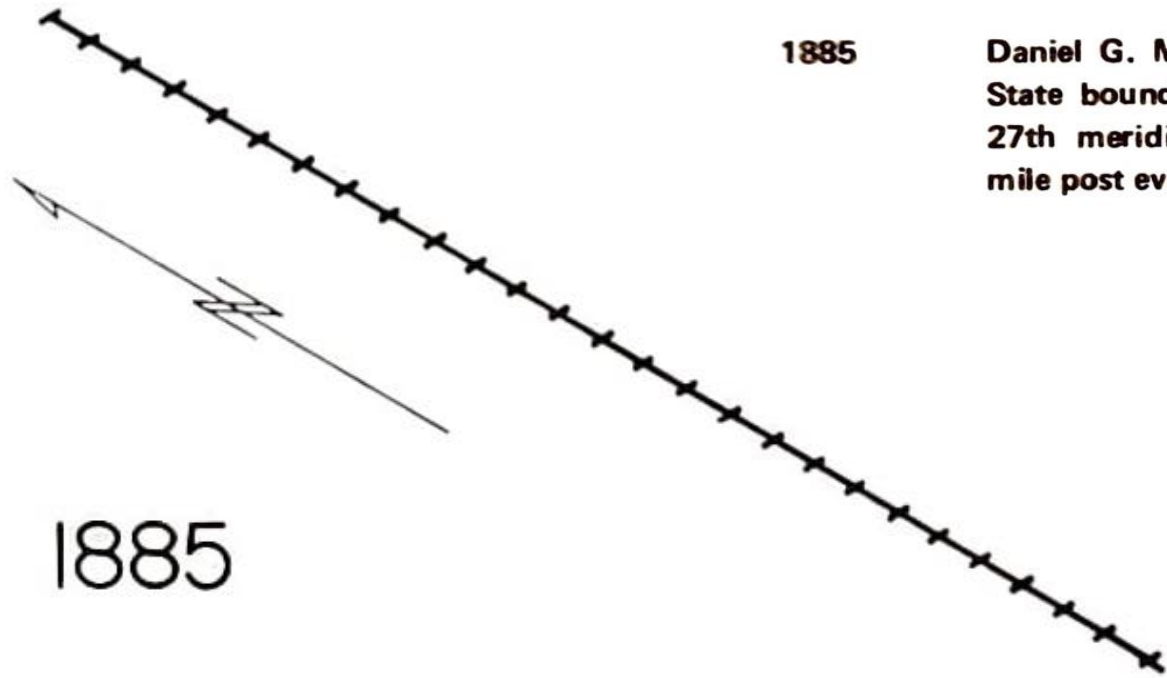
Resurveys – BLM Dependent Resurvey T6N,  
R61E, P.M.M., Fallon County, MT

U S DEPARTMENT OF THE INTERIOR  
Bureau of Land Management  
Cadastral Survey Training Program

**Public Lands Surveying**  
**• A Casebook •**

prepared by  
The Cadastral Training Staff  
1975

# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT



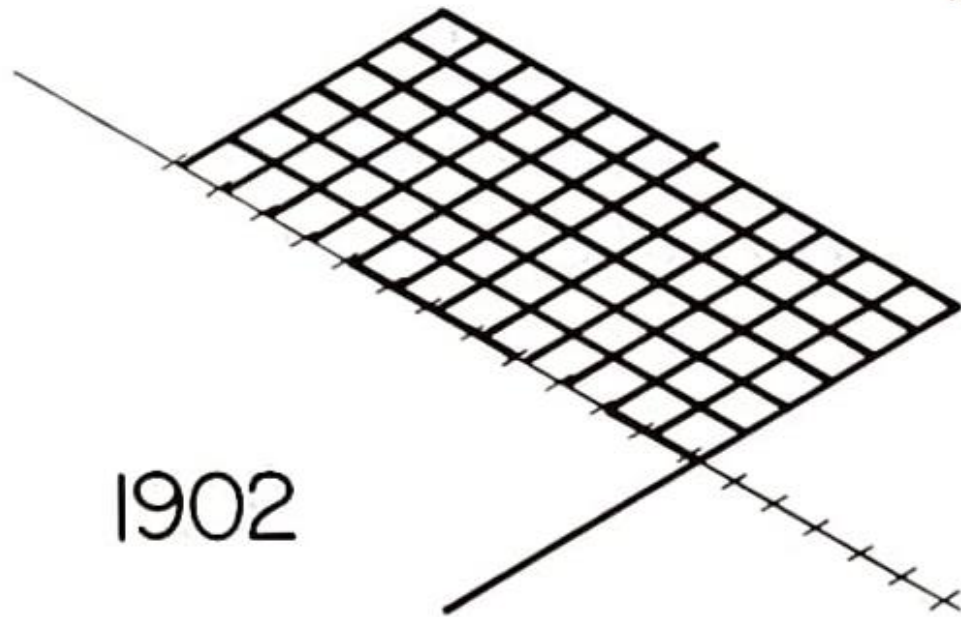
1885

**Daniel G. Major surveyed the Montana-North Dakota State boundary. Major ran the line North, along the 27th meridian west of Washington, D.C., and set a mile post every 80 chains.**

1885



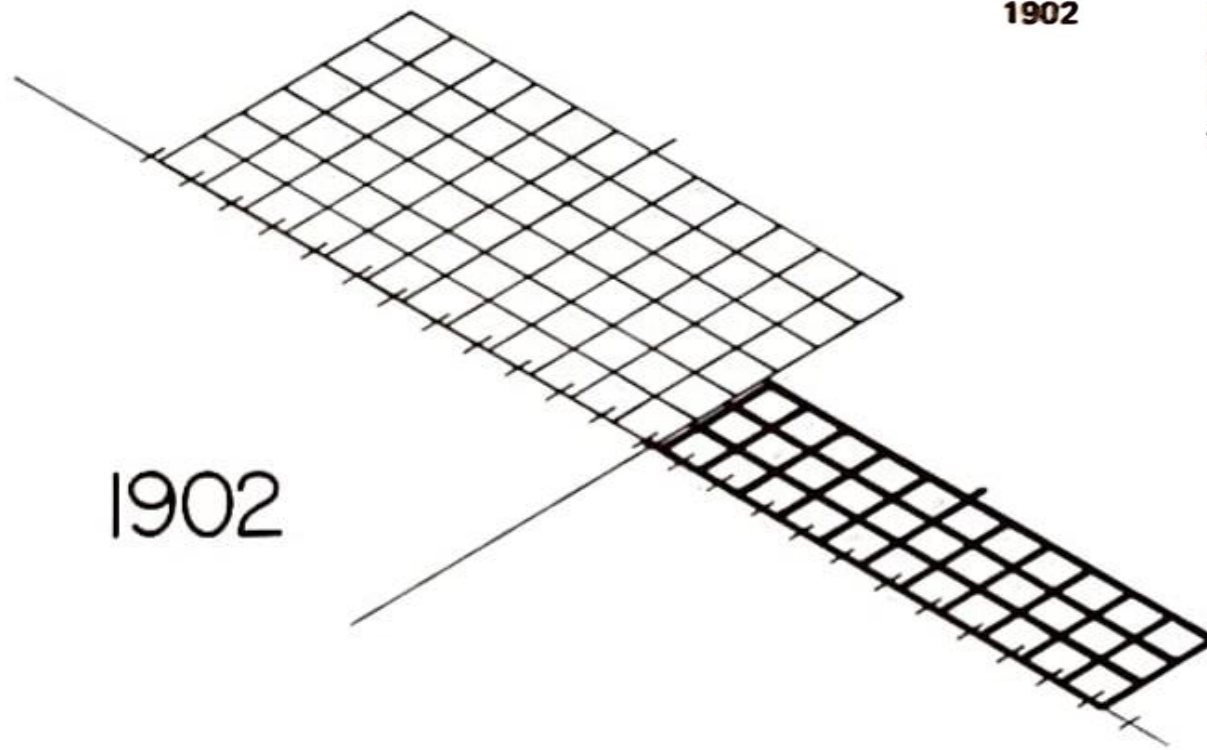
# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT



1902

**George K. Dike surveyed the Eighth Standard Parallel, exterior boundaries and subdivisional lines of Tps. 133 and 134 N., R. 106 W., 5th P.M., North Dakota. Dike retraced the state boundary between the 89-91 and 93-97 mile posts.**

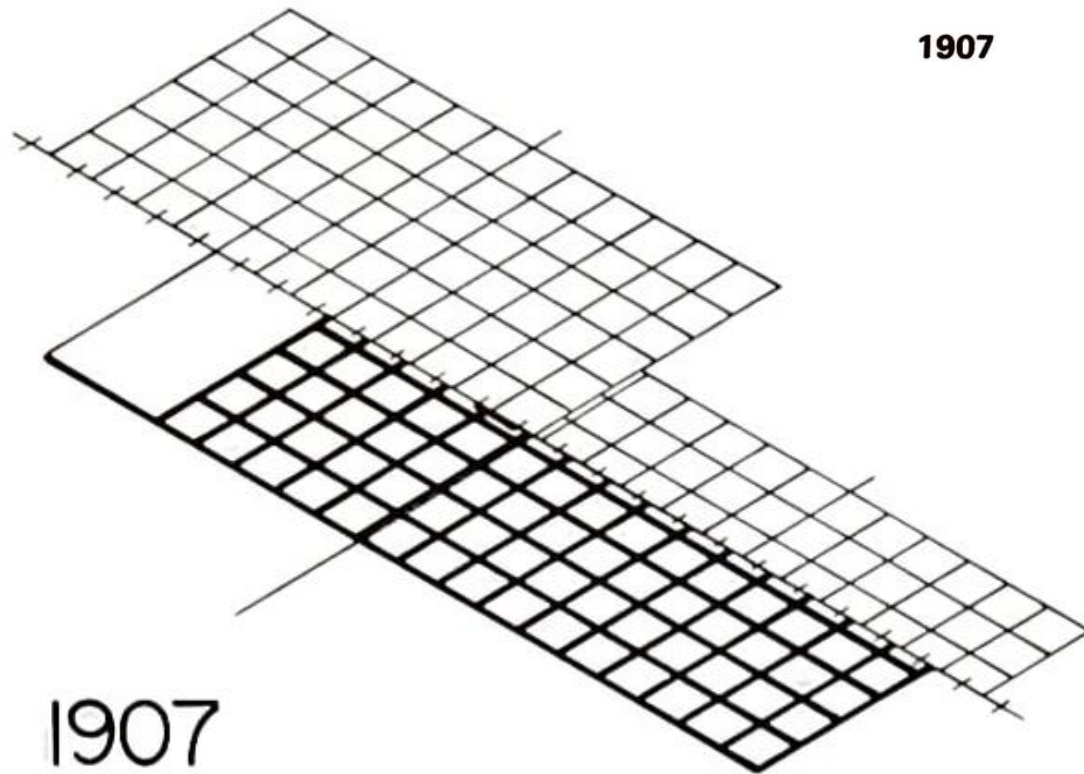
# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT



1902

Hiram A. Soule surveyed the exterior boundaries and subdivisional lines of Tps. 131 and 132 N., R. 107 W., 5th P.M., North Dakota. Soule retraced the state boundary between the 78-89 mile posts.

# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT

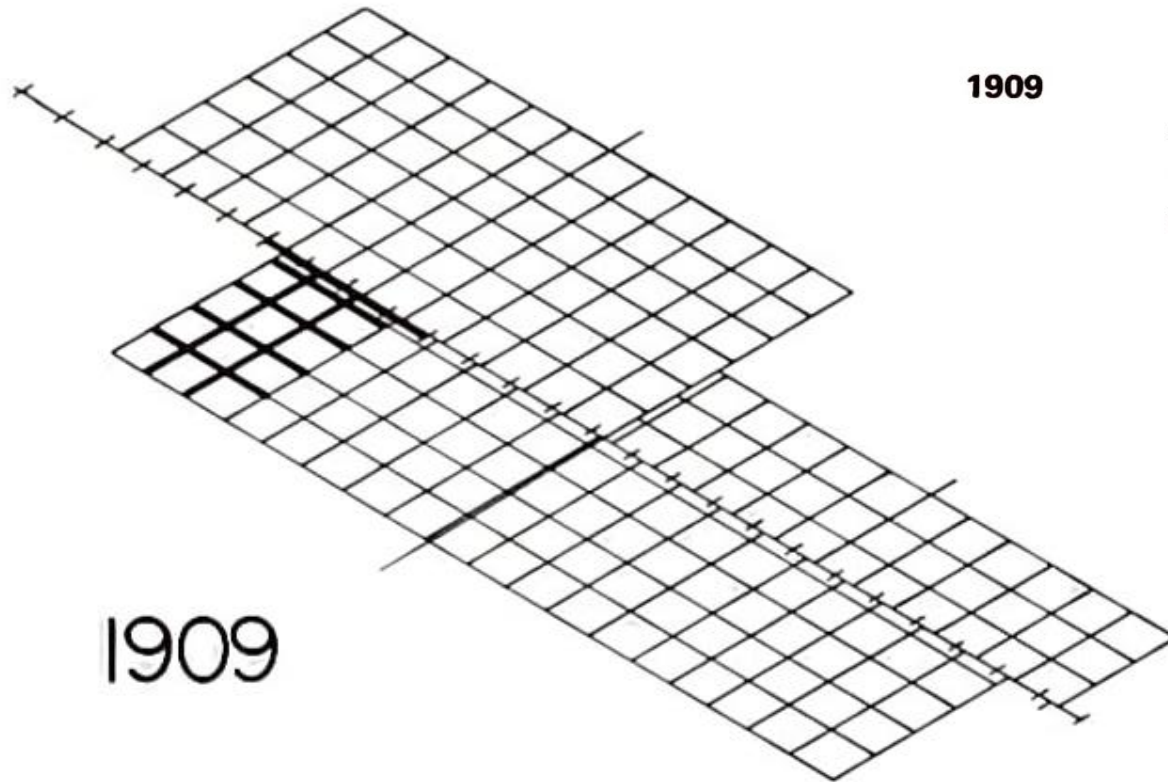


1907

R.F. Scott and H.E. Fearnall surveyed the exterior boundaries and subdivisional lines of Tps. 5 and 6 N., R. 61 E., and the south half of T. 7 N., R. 61 E., Principal Meridian, Montana, as shown on the plats approved February 2, 1909, figures 1, 2 and 3. Scott and Fearnall retraced the state boundary between the 89-90 mile posts. The remainder of the boundary retracements were taken from the North Dakota record executed by Dike and Soule.

1907

# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT



1909

**Lewellyn D. Lyman completed T. 7 N., R. 61 E., as shown on the plat approved April 9, 1910, figure 4. Lyman retraced the state boundary between the 93-97 mile posts.**

1909

# Resurveys – BLM Dependent Resurvey T6N, R61E, P.M.M., Fallon County, MT

## Conditions Found on the Ground

Most of the mile posts and closing corners along the state boundary were lost. After retracements and search the 83 and 96 mile posts were recovered. Only five original closing corners were recovered. One of these was the closing corner of the Eighth Standard Parallel, 5th P.M., North Dakota. Figure 5 shows the latest record courses and distances between mile posts, record distances from mile posts to closing corners, the recovered corners (on each side of the state line) and the relative coordinates of mile posts 83 and 96 as determined by the present retracements.

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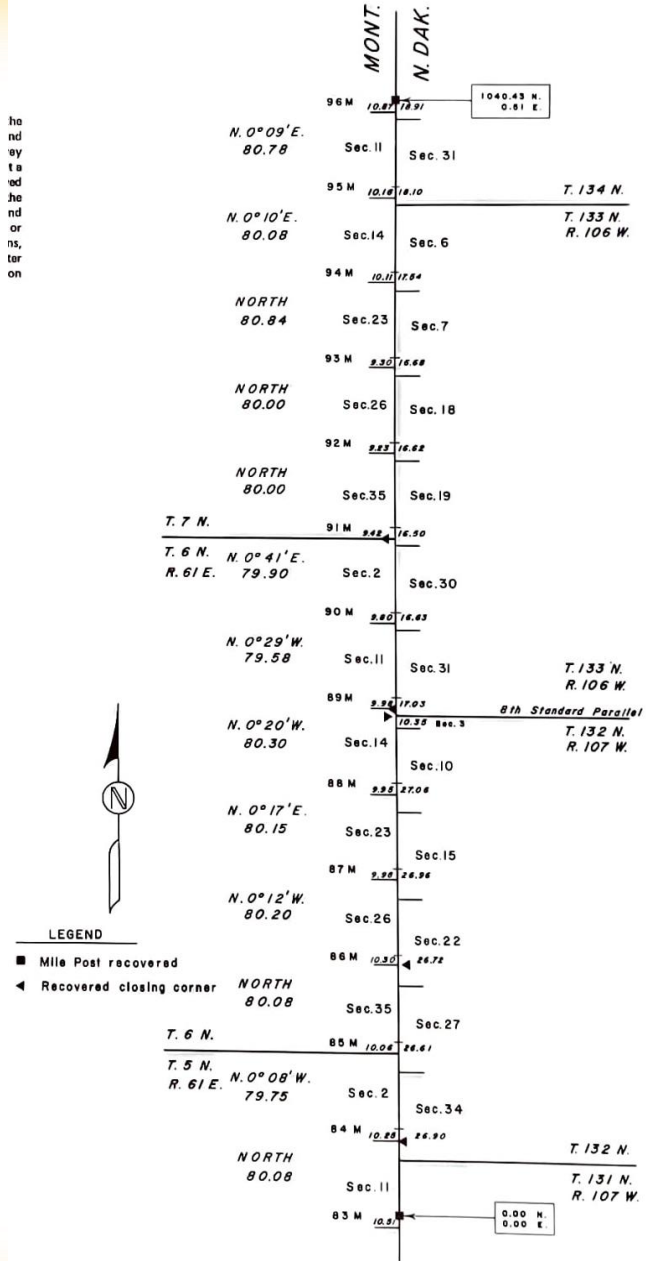
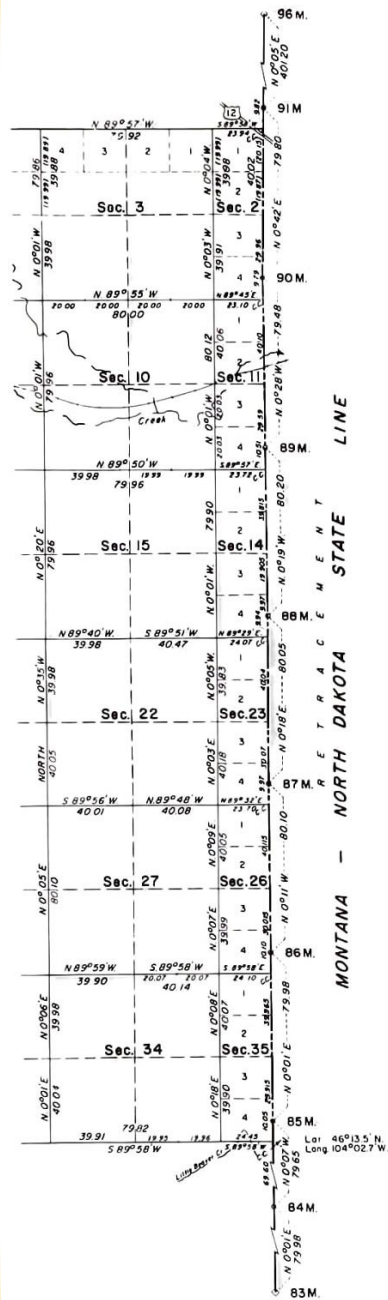


Figure 5 - Record Courses and Recovery Diagram

### Conditions Found on the Ground

Most of the mile posts and closing corners along the state boundary were lost. After retracements and search the 83 and 96 mile posts were recovered. Only five original closing corners were recovered. One of these was the closing corner of the Eighth Standard Parallel, 5th P.M., North Dakota. Figure 5 shows the latest record courses and distances between mile posts, record distances from mile posts to closing corners, the recovered corners (on each side of the state line) and the relative coordinates of mile posts 83 and 96 as determined by the present retracements.



## Solution

The plat accepted September 5, 1969, figure 6, illustrates the final solution.

The points for the missing mile posts were restored by the irregular boundary method of proportioning. Only the 83 and 96 mile posts were remonumented. After temporary points were established for the missing mile posts the lost closing corners were restored by single proportionment measurement between mile posts. The  $\frac{1}{4}$  section corners were established at midpoint between closing corners, except the East  $\frac{1}{4}$  corner of section 2, which was placed proportionately 40 chains north of the closing corner of sections 2 and 11, based on the record plat, figure 2.

## Resurveys – Well Plats

- Several MPs have either been recovered or reset per oil well location plats



# Review of Original Survey – Monuments

- It was obviously monumented very well
- Peck's resurvey recovered all but one monument in the 66 mile portion that was resurveyed
- The GLO surveys in the Sidney/Williston area that are close to the state line appear to have found the line and support a common location of the line
- The oil well location plats depict original mileposts having been found

# Review of Original Survey – Longitude

- Used a best-fit line through closing corners and apparent occupation/common-use lines east of Wibaux
  - Had 8 miles of evidence shot – worked within +/-15'
- Offset the line west 6 miles, 28 chains, and 57 links and intersected with the railroad tracks at Wibaux to determine and approximate longitude of the Mingusville Observatory

Approx. Longitude @ Mingusville = **104°10'47.8" West**

- Determined an approximate longitude at the Washburn Observatory using Google Earth

Approx. Longitude @ Washburn Obs. = **89°24'32.6" West**

# Review of Original Survey – Longitude

Approx. Longitude @ Mingusville =  $104^{\circ}10'47.8''$  West

- Approx. Longitude @ Washburn Obs. =  $89^{\circ}24'32.6''$  West

Difference =  $14^{\circ}46'15.2''$  West

Converted to Time = 0 hrs. 59 min. 05 sec.

-Time per Major/Holden = 0 hrs. 59 min. 6.49 sec.

Difference = -1.49 seconds

## Review of Original Survey – Longitude

The western boundary of Dakotah is fixed by law as  $27^{\circ}$  west of Washington.

$27^{\circ}$  W. of Washington is  $1^{\text{h}} 48^{\text{m}} 0^{\text{s}}.00$ ,  
Madison W. of Washington 0 49 25.80,  
Boundary W. of Madison 0 58.34.20.

The latitude of his station (near Mingusville, Dorsey Co., Montana) was  $+47^{\circ} 0' 30''$ .  $1^{\text{s}}$  of time at that latitude is about 1039.6 feet.

Note: 1 second of time =  $15''$  of Longitude

# Review of Original Survey – Longitude

- The NAD83 longitude per a 2009 article entitled “*The Washington Meridian*” in American Surveyor called for a longitude of **77°03’02.3” West**
  - Less reliable sources were within 2” of the value reported in American Surveyor
  - The approx. center of the dome on Google Earth is 77°03’05.2”
- Adding 27° equals an approx. longitude of **104°03’02.3”**
- Longitude at approx. state line east of Wibaux = **104°02’43.3”**
- Approx. NAD83 difference = **19” (longitude)**

## Review of Original Survey – The Line

- Compiled geographic coordinates on the line from past survey data, autonomous GPS measurements, approx. locations determined from oil well plats, and from CCs and apparent occupation/common-use lines
- Also evaluated Peck's dependent resurvey data and reviewed GLO township plats on both sides of the line near Fairview, MT

# Review of Original Survey – The Line

## Schedule of Approximate Coordinates

SE COR. MT	LAT: 44°59'53.2"	LON: 104°02'22.8"	DELTA: 39.5"
MP-47	LAT: 45°40'36.3"	LON: 104°02'32.6"	DELTA: 29.7"
E. OF WIBAUX	LAT: 46°59'10.4"	LON: 104°02'43.3"	DELTA: 19.0"
MP-184	LAT: 47°39'39.1"	LON: 104°02'37.0"	DELTA: 25.3"
MP-189	LAT: 47°43'56.9"	LON: 104°02'36.9"	DELTA: 25.4"
MP-206	LAT: 47°58'42.3"	LON: 104°02'37.6"	DELTA: 24.7"
MP-230	LAT: 48°19'39.3"	LON: 104°02'46.4"	DELTA: 15.9"
NE COR. MT	LAT: 48°59'59.6"	LON: 104°02'55.3"	DELTA: 7.0"

## Review of Original Survey – The Line

- Overall per the Peck Resurvey
- Distances were typically within a chain/mile
- Bearings typically west of north and could vary over a degree at times
  - The longitude of the mile posts substantiates this



# Conclusion

- Major was faithful in his duties in that his monuments have consistently been found and continue to be found
- Given the time and the conditions, the determination of longitude seems more than reasonable
- The disregard for the NE corner of Wyoming is somewhat questionable considering the potential sources of error – i.e. the awkward use of the transit along the railroad, the difference in the ephemeris between Major and Holden, and chaining 137 miles south of the observatory

Questions?