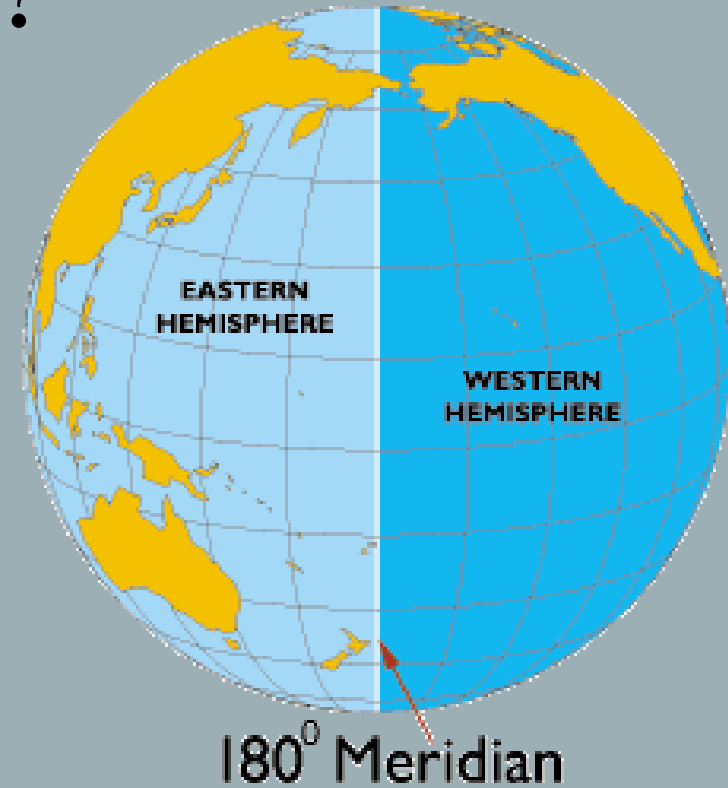


EARTHQUAKES

By: Sofia Romero & Cristina Noriega

RESEARCH QUESTION

Which hemisphere is affected by larger earthquake magnitudes?



Data

- <https://earthquake.usgs.gov/>
- Original data from August 28 2018 – September 26 2018 (30days)

The screenshot displays the USGS Earthquake Hazards Program website. The header features the USGS logo with the tagline "science for a changing world" and a green seismic waveform. Below the header, a dark blue navigation bar contains the text "Earthquake Hazards Program".

On the left side, there is a sidebar with a "← Earthquakes" link and a list of menu items: "Latest Earthquakes", "Earthquake Lists, Maps & Statistics", "Search Earthquake Catalog", "Real-time Notifications, Feeds & Web Services" (which is highlighted), "Information by Region", "ANSS ComCat Documentation", and "Errata for Latest Earthquakes". At the bottom of the sidebar is a dark blue vertical menu with links to "Earthquakes", "Hazards", "Data & Products", "Learn", and "Monitoring".

The main content area is titled "Real-time Notifications, Feeds, and Web Services". Under the "Real-time Notifications" section, an information icon (i) is followed by the text: "Know about earthquakes just after they happen. The ENS and TED services each offer something different, depending on your interests."

Below this, there are two columns of information:

- Earthquake Notification Service (ENS)**: Accompanied by an envelope icon with a seismic waveform. The text states: "The Earthquake Notification Service (ENS) is a free service that sends you automated notifications to your email or cell phone when earthquakes happen."
- Tweet Earthquake Dispatch (TED)**: Accompanied by a USGS TED logo. The text states: "Tweet Earthquake Dispatch (TED) offers two Twitter accounts. On average, each account will produce about one tweet per day."

At the bottom, the "Real-time Feeds" section features the ANSS logo (a stylized waveform) and an information icon (i) with the text: "To subscribe to a real-time feed, select a format (ATOM is the best choice for most), then select which feed you want from the list on that page, and copy the URL into your feed reader of choice."

SAMPLE DATA

- Simple random sample
- n=50
- **Population:** Earthquakes with a magnitude greater than or equal to 4.0
- **Variables:**
 - Magnitude,
 - Hemisphere
 - Day
 - Date
 - Longitude
 - Latitude
 - Depth
 - Location

2	2018-08-29	15.5084	-147.138	45.84	152km ENE of	1	E	1
2	2018-08-29	-24.2378	-67.0153	167.31	4.2 70km W of S	1	W	1
2	2018-08-29	-7.7836	118.737	10	4.9 57km NNE of	1	E	2
2	2018-08-29	-18.0406	-178.3529	581.95	4.4 291km N of	1	E	2
2	2018-08-29	-18.1971	-178.0307	548.77	4.4 280km NNE	1	E	2
2	2018-08-29	-8.5511	121.176	192.83	4.1 2km ENE of	1	E	2
2	2018-08-29	23.0193	144.6647	10	4.5 275km N of	1	E	2
3	2018-08-30	-28.146	62.8971	10	4.7 Southwest Is	1	E	2
4	2018-08-31	-32.2062	-70.4787	96.26	5 64km NNE of	1	W	1
4	2018-08-31	69.0714	-11.0238	10	4.6 224km SSW	1	W	1
5	2018-09-01	-5.5167	147.1735	217.56	4.6 134km N of	1	E	2
6	2018-09-02	-28.2715	-70.7361	92.87	4.7 33km N of V	1	W	1
6	2018-09-02	-2.5225	-79.3462	79.74	4.9 13km S of La	1	W	1
6	2018-09-02	-8.1402	116.4471	8.7	5.3 10km NNE of	1	E	2
7	2018-09-03	-19.4208	169.5981	254.02	4.8 37km ENE of	1	E	2
8	2018-09-04	-22.1248	170.3302	35	4.8 179km W of	1	E	2
8	2018-09-04	40.1648	-10.5201	10	4.8 132km NW of	1	W	1
8	2018-09-04	39.5584	76.6279	35.9	4.4 45km ESE of	1	E	2
9	2018-09-05	54.7031	58.0747	10	4.2 9km SW of K	1	E	2
9	2018-09-05	-33.6142	-179.9875	94.98	4.3 262km SSW	1	E	2
11	2018-09-07	-18.3443	167.8609	10	4.5 83km SW of	1	E	2
12	2018-09-08	-22.2209	170.1536	10	5.7 196km W of	1	E	2
14	2018-09-10	14.5346	-92.9678	35	4.6 62km WSW	1	W	1
14	2018-09-10	37.8122	141.1211	65.41	4.3 33km ESE of	1	E	2
15	2018-09-11	30.3898	131.0138	35	4.6 38km S of N	1	E	2
15	2018-09-11	-5.6197	152.0809	64.25	4.6 141km S of I	1	E	2
16	2018-09-12	-17.9417	-177.8935	585.62	4.4 Fiji region	1	E	2
17	2018-09-13	36.4858	71.2288	229.61	4.6 34km SW of	1	E	2
17	2018-09-13	-35.0597	-179.4059	10	4.8 East of the N	1	E	2
19	2018-09-15	-1.3652	-15.3366	10	4.7 North of Asc	1	W	1
19	2018-09-15	35.4104	141.2567	31.09	4.5 52km SE of I	1	E	2
21	2018-09-17	36.7117	71.0995	245.85	4.3 29km SE of J	1	E	2
22	2018-09-18	36.0106	139.7538	90.02	4.6 3km N of Ka	1	E	2
22	2018-09-18	-12.7695	45.3734	10	4.7 10km ENE of	1	E	2
22	2018-09-18	-8.3287	157.2172	10	5.8 48km ESE of	1	E	2
24	2018-09-20	-7.7359	154.6306	10	4.7 183km SSW	1	E	2
24	2018-09-20	-6.5013	152.6617	10	5.4 228km S of T	1	E	2
25	2018-09-21	-43.7511	-75.6678	10	4 180km WSV	1	W	1
25	2018-09-21	13.0811	-81.1106	10	4.6 42km SE of I	1	W	1
26	2018-09-22	51.6328	-177.3382	51.97	4.6 54km WSW	1	W	1
26	2018-09-22	-9.0536	158.2066	10	4.7 143km SW of	1	E	2
27	2018-09-23	36.5007	140.6637	54.04	4.6 9km ENE of	1	E	2
27	2018-09-23	-24.3482	-70.0652	61.35	4.2 84km SSE of	1	W	1
29	2018-09-25	-21.4562	-67.3153	201.96	4.3 121km SSW	1	W	1
29	2018-09-25	16.5251	-98.8425	35	4.4 7km SSW of	1	W	1

SAMPLE RESULT

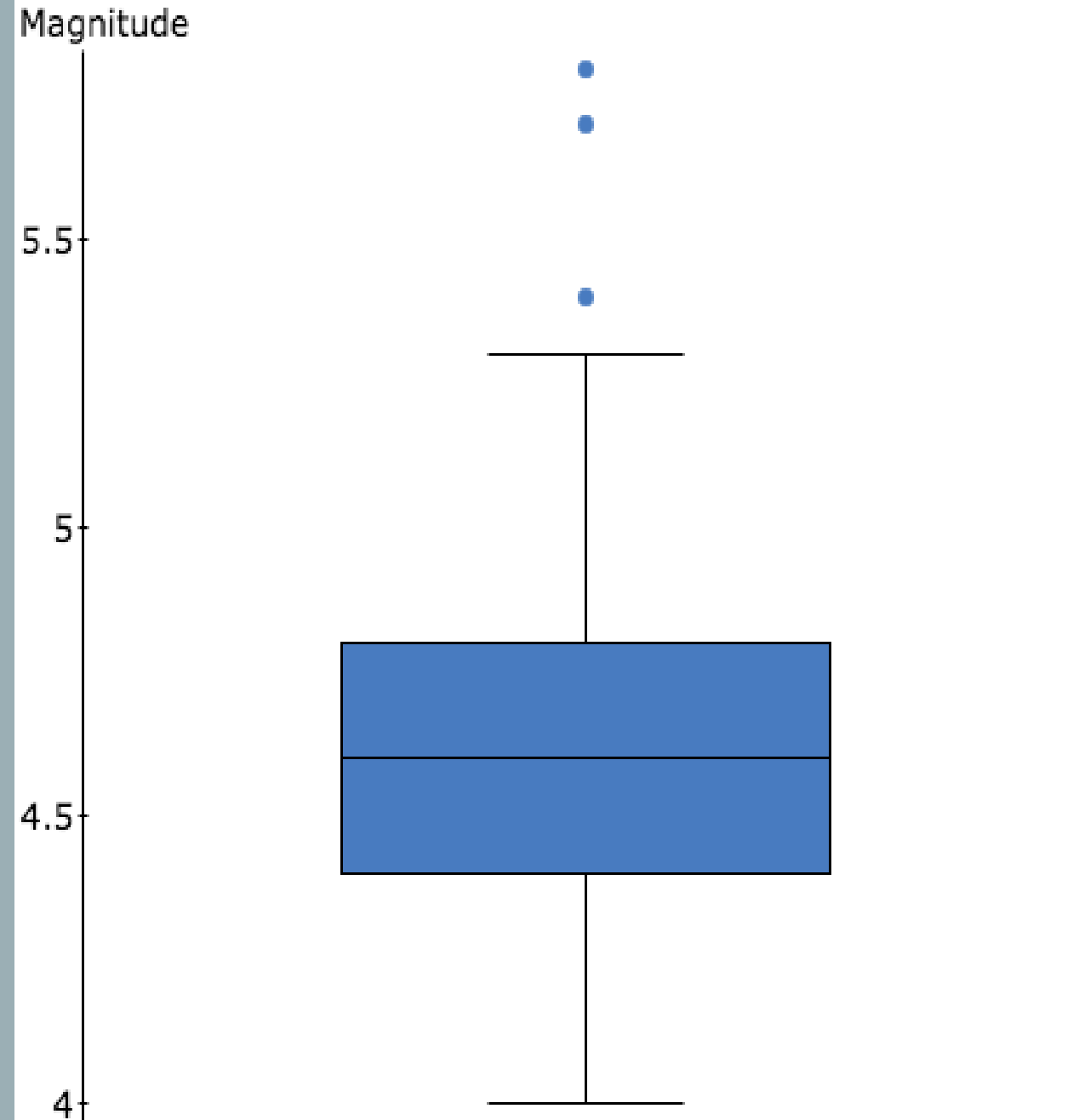
Boxplot

Sample mean: 4.6 magnitude

Skewed right

Outliers: 3 with
magnitudes(5.4,5.7,5.8)

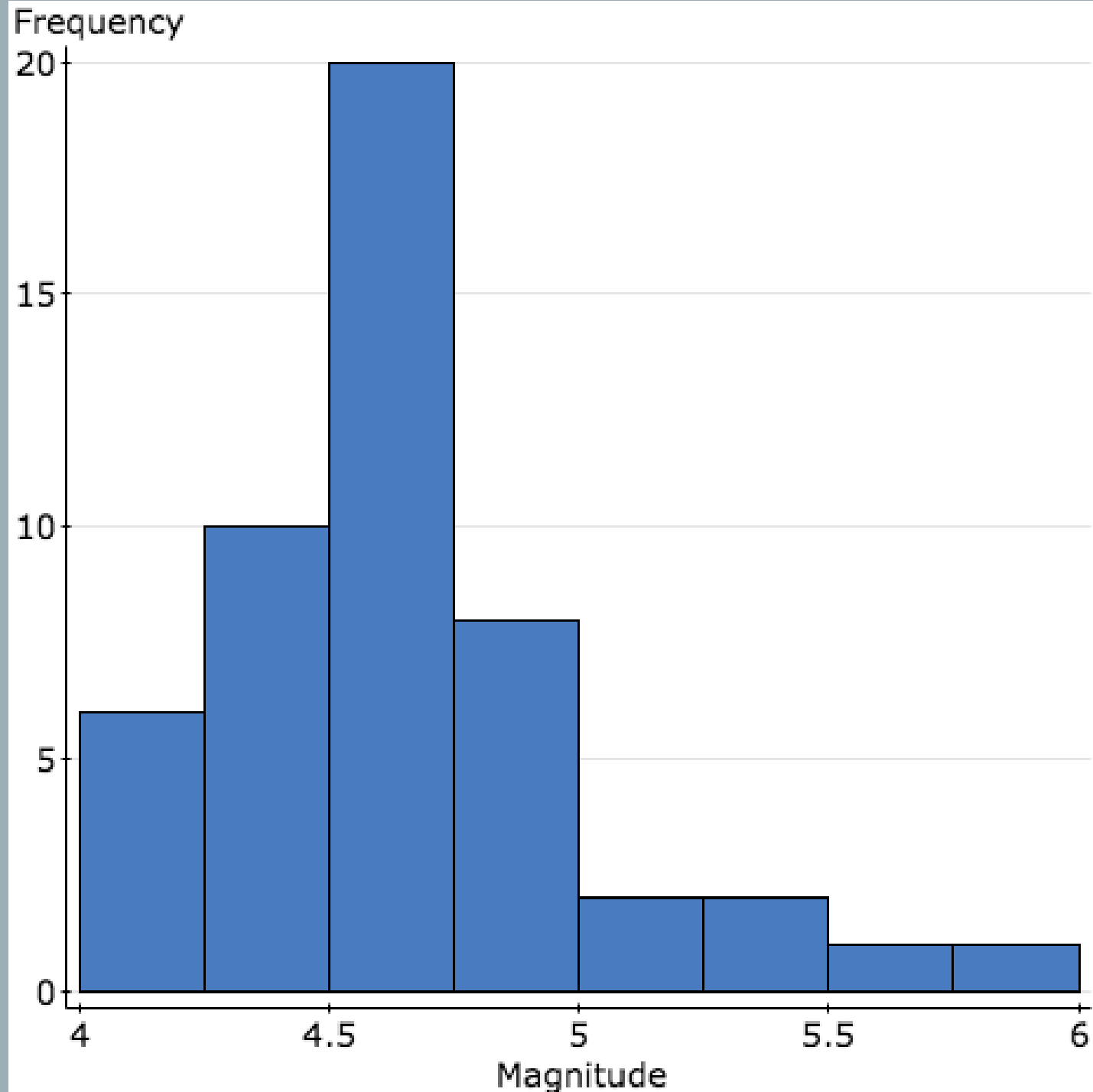
Most earthquakes in East
hemisphere 33/50



Magnitude Frequency

Histogram

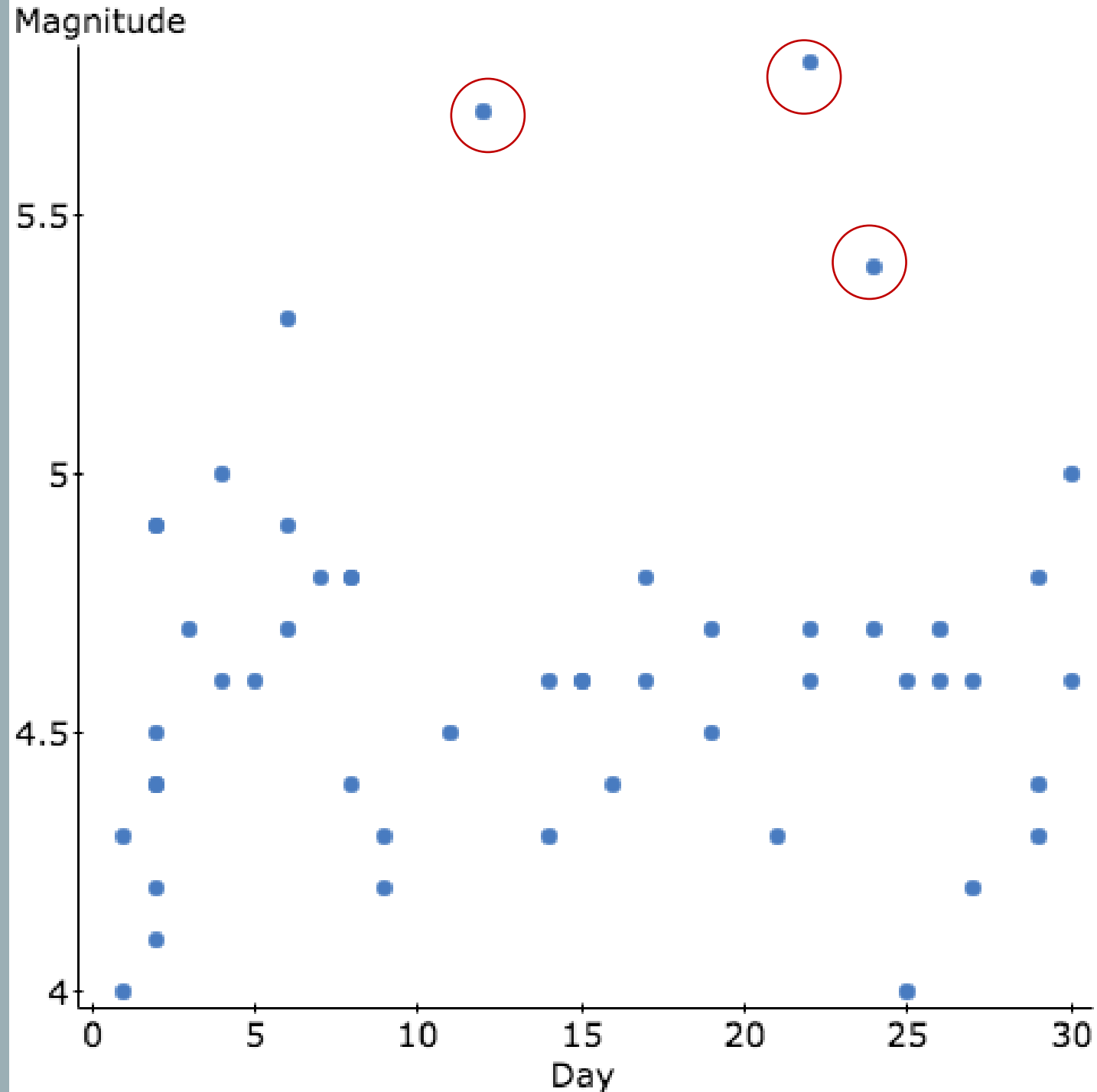
- Skewed right
- Most frequent earthquakes magnitudes greater than 4.5 but less than 4.75



Day vs Magnitude

Scatterplot

- Outliers circled in red
- Highest magnitudes above 5.5
- Lowest magnitudes 4.0



SIMPLE LINEAR REGRESSION

Results:

Dependent Variable: mag

Independent Variable: latitude

$\text{mag} = 4.6375773 - 0.0027078427 \text{ latitude}$

Sample size: 50

R (correlation coefficient) = -0.21202815

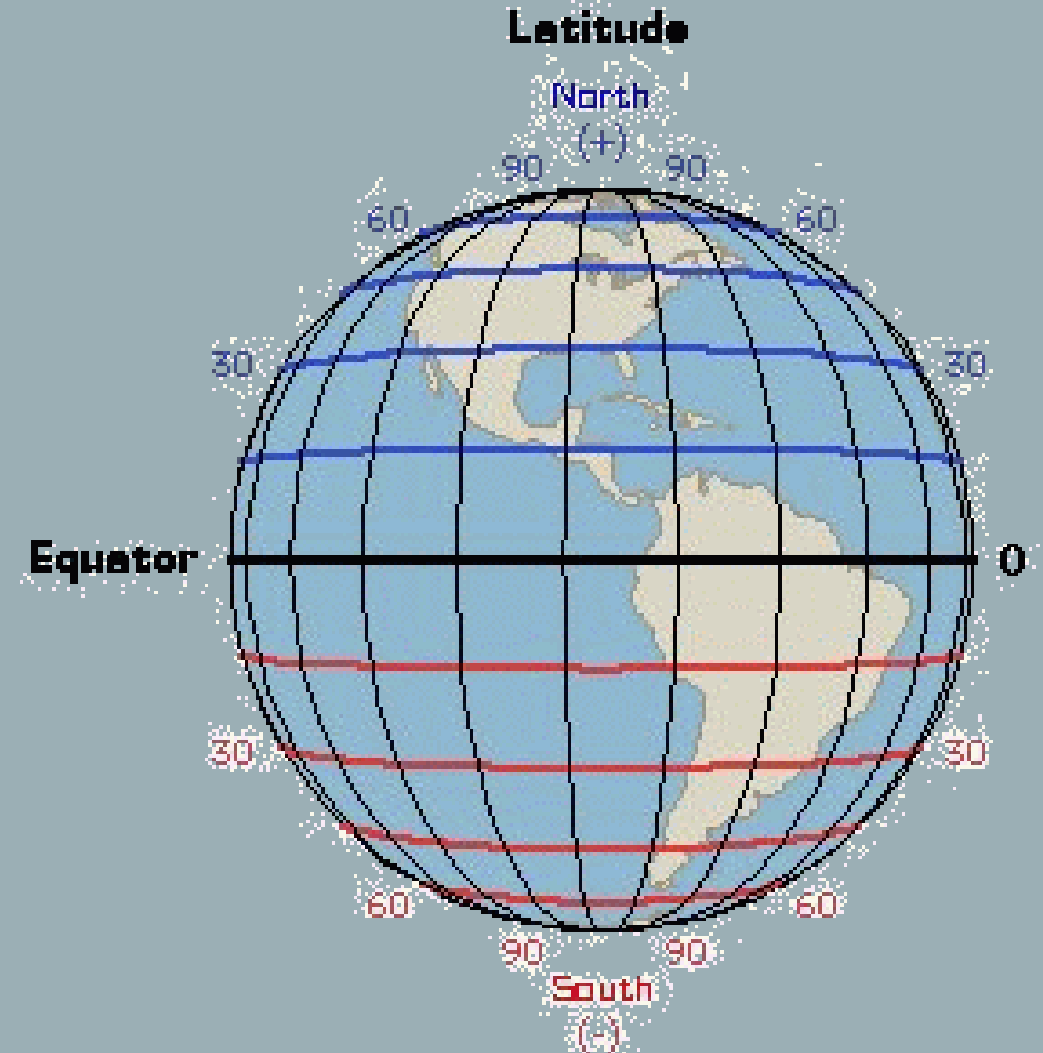
R-sq = 0.044955936

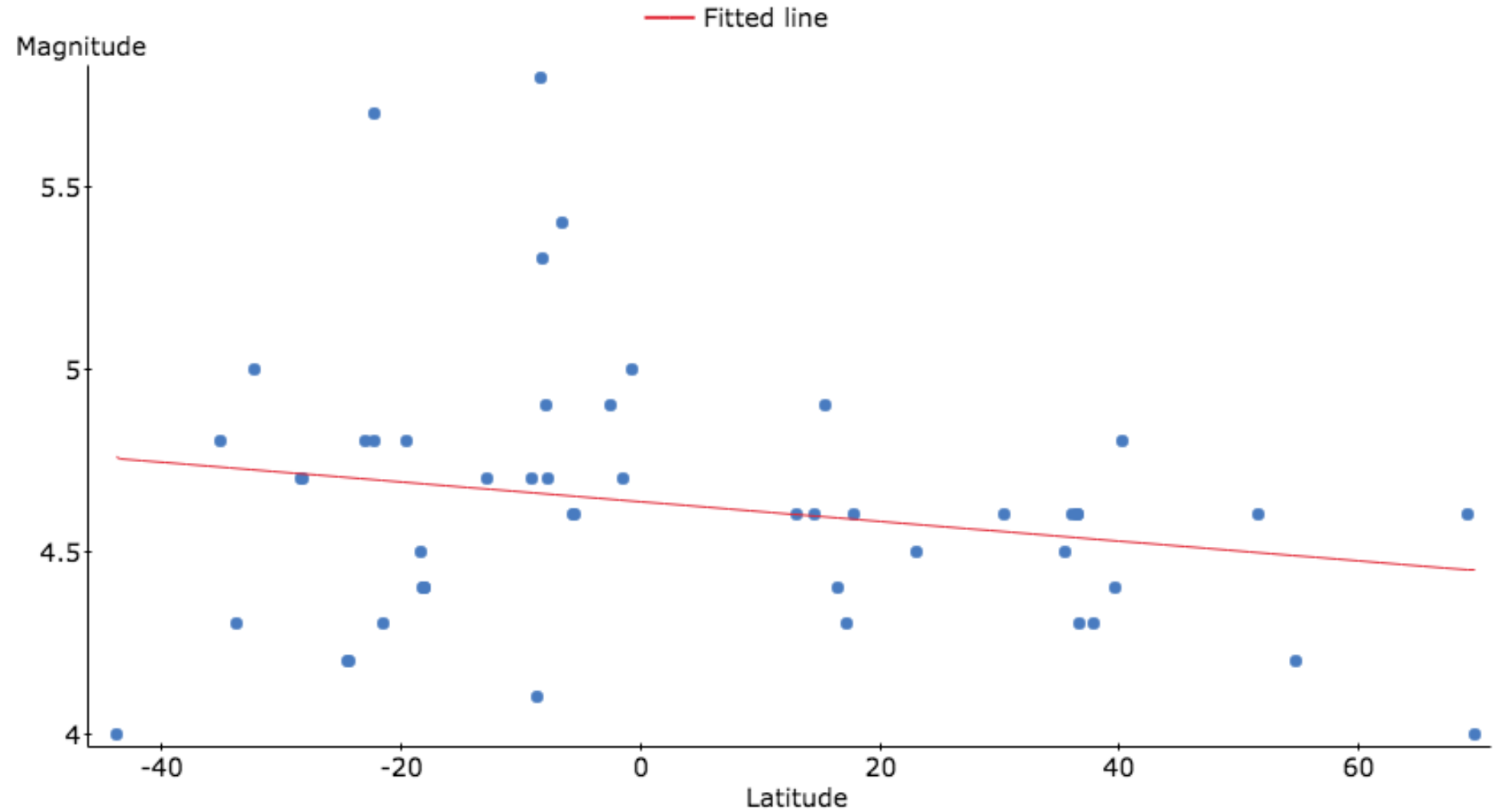
Estimate of error standard deviation: 0.36568031

T-stat: -1.503

P-value: .1394

Conclusion: Weak Negative Correlation





LATITUDE VS. MAGNITUDE

HYPOTHESIS

Does the East hemisphere experience greater earthquake magnitudes than West East hemisphere?

Two sample T test:

μ_1 : Mean of East

μ_2 : Mean of West

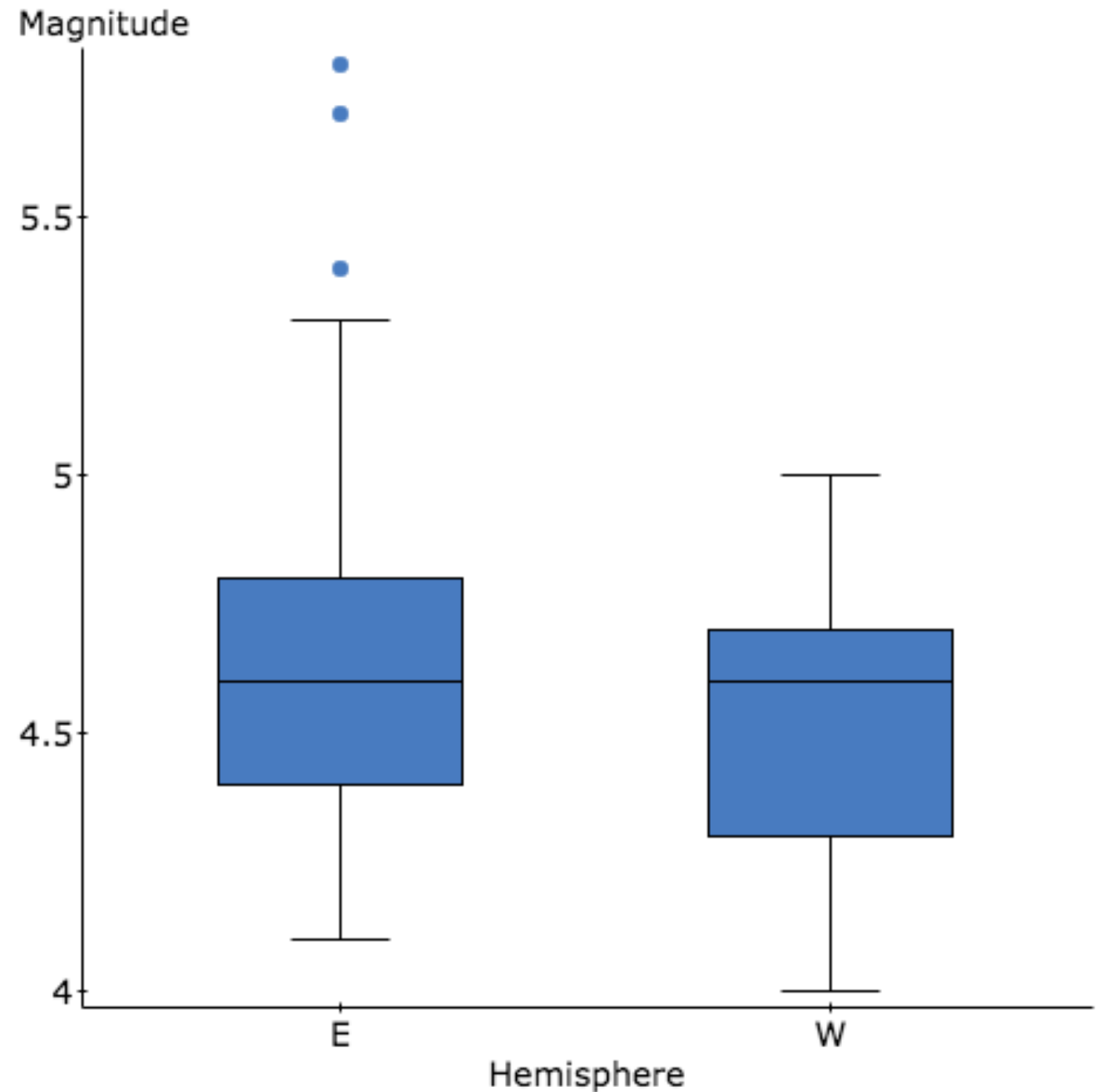
$H_0 : \mu_1 - \mu_2 = 0$

$H_A : \mu_1 - \mu_2 > 0$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

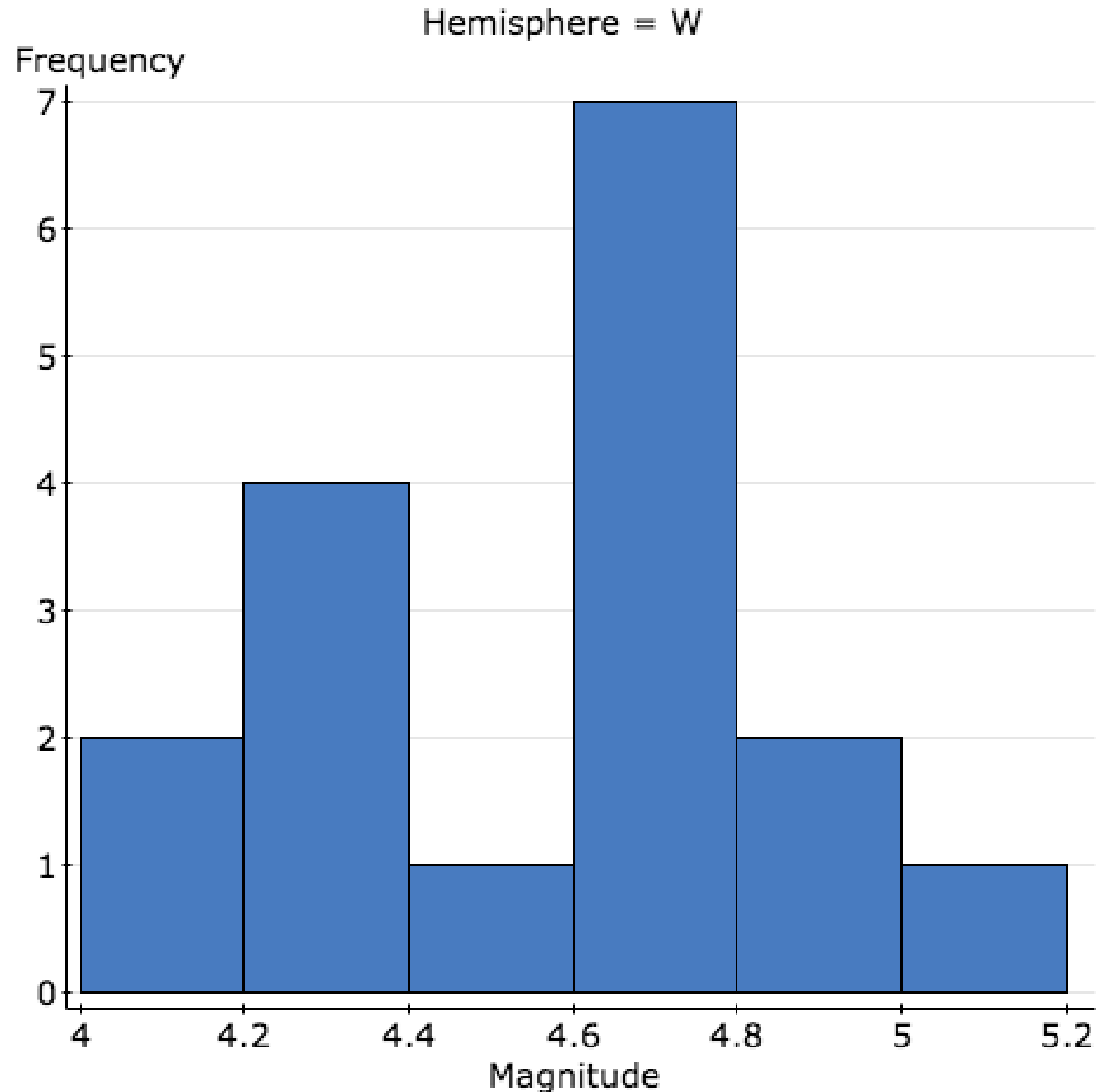
HEMISPHERE VS MAGNITUDE

- East Hemisphere:
 - Skewed right
 - Larger magnitudes
 - Mean: 4.7
- West Hemisphere:
 - Normal distribution
 - Bell shaped
 - Smaller magnitudes
 - Mean: 4.5



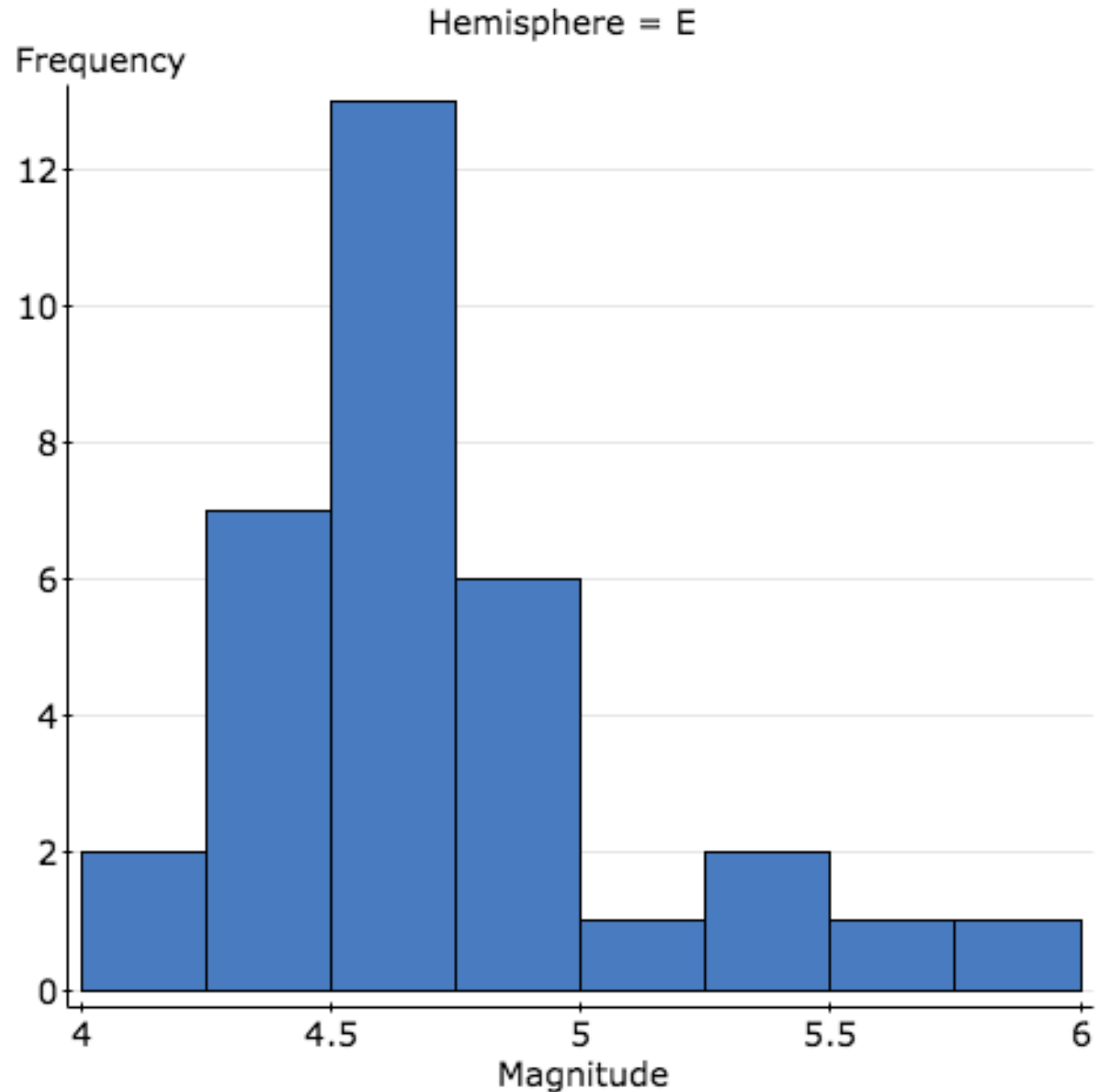
WEST HEMISPHERE: MAGNITUDE VS FREQUENCY

- Most frequent earthquakes magnitudes greater than 4.6 but less than 4.8
- Slightly skewed to right



EAST HEMISPHERE: MAGNITUDE VS FREQUENCY

- Skewed to the right
- Most frequent earthquake magnitudes greater than 4.5 but less than 4.75
- Outliers greater than 5.5



CONCLUSION

$t = 1.96$.

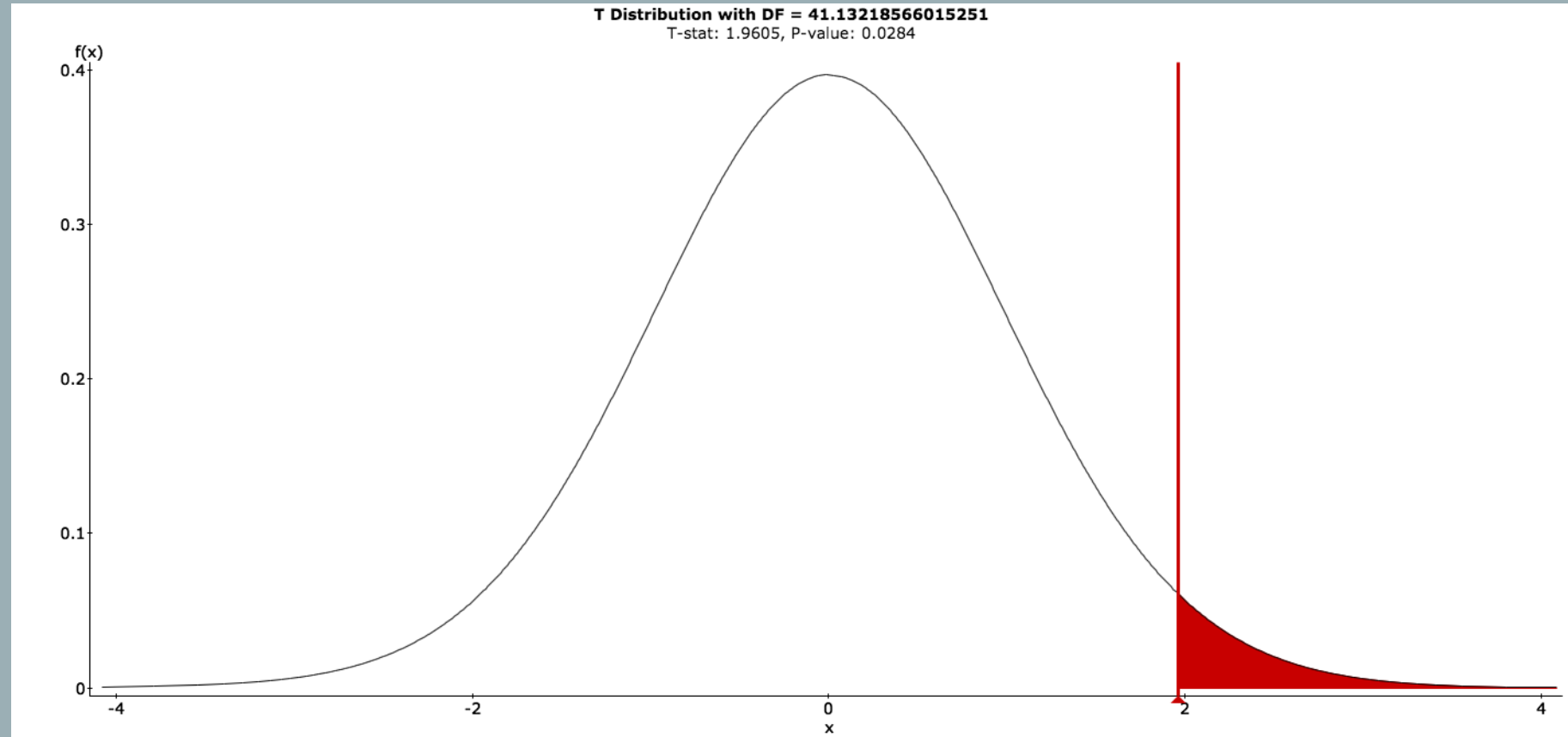
$\alpha = .05$

p-value = .0284

$.0284 < .05$

P-value is less than α

Reject H_0



There is sufficient evidence to warrant rejection of the claim that the mean magnitude for the East hemisphere is greater than the West hemisphere.