

# Earth Science

## Predicting Riverside's next eruption Geysers of Yellowstone National Park - Teachers Lab

6-8

Lesson plan by John Graves, modified by TBI



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**National Science Standards:**

- NS.5-8.1 - Science as Inquiry
- NS.5-8.4 - Earth and Space Science
- NS.5-8.5 - Science and Technology
- NS.5-8.7 - History and Nature of Science
- NT.K-12.5 - Technology Research Tools
- NM-NUM.6-8.3 - Compute Fluently and Make Reasonable Estimates
- NM-DATA.6-8.3 - Develop and Evaluate Inferences and Predictions That are Based on Data
- NM-CONN.PK-12.3 - Recognize and Apply Mathematics in Contexts Outside of Mathematics
- NT.K-12.5 - Technology and Research Tools

**VOCABULARY**

Eruption, Interval, Duration

**LESSON GOALS:**

Understanding that the eruption of predictable geysers, like Old Faithful in Yellowstone National Park, is dependent on two variables: the duration of the previous eruption and the interval between eruptions. Using actual eruption data from Riverside geyser, students create a prediction model exactly like the one used by rangers in Yellowstone to inform visitors of the next eruption of predictable geysers.

**LEARNER OBJECTIVES:**

1. Students will understand the relationship between the duration of a geyser's eruption and the interval between eruptions as they relate to predicting an eruption.
2. Students will create a graph to manipulate, analyze and interpret data.
3. Students will use graphing calculators (or graph paper) as a tool to better understand and communicate data.

## BACKGROUND CONTENT:

Old Faithful is one of the world's most popular geysers. Located in Yellowstone National Park, it was given its name by the Washburn Expedition in 1870. Classified as a cone-type geyser, it has intervals, which is the time between eruptions, that range from 35 to 120 minutes. The duration, the length of time that the geyser is erupting, ranges from 1 ½ to nearly 5 minutes, with an eruption height of 90 to 184 feet. Another less famous, however, just as predictable geyser is Riverside geyser located on the edge of the Firehole River less than a mile away from Old Faithful geyser. Riverside is also a cone geyser. This geyser has intervals of 5 ½ to 7 hours with the duration of the eruption lasting ½ hour. The geyser erupts 75 feet in the air over the river. The eruption process is highly complex, but basically a subterranean "plumbing system" contains water that is heated by magma that is near the earth's surface. This magma is within a mile of the surface in Yellowstone. The heated water reaches temperatures above boiling due to the pressure of the water in the plumbing system. At some point, the super-heated water bursts into steam setting off a chain-reaction in which other water molecules convert to steam. The volume of steam is 1500 times greater than that of water and the resulting increase in volume pushes water out of an opening in the earth's surface, causing a geyser eruption. The eruption continues as long as there is ample water in the plumbing system. When the amount of water is reduced and the pressure in the system is decreased, the eruption ceases, allowing the system to recharge for another eruption. Some geysers have a more stable plumbing system and water supply causing them to be "predicable." Such is the case with Riverside and Old Faithful.

## MATERIALS AND SUPPLIES:

### 1. Data set of Riverside eruptions.

Available from

<http://www.geyserstudy.org/geyser.aspx?pGeyserNo=RIVERSIDE>

move to the bottom of the page and you will find several data files.

Enclosed with lesson is 2007 data obtained on August 8, 2007.

The data set includes the actual date and time of eruptions and the duration. The duration and interval is already calculated for you. This data is collected remotely using a data logger that measures temperature of overflow water. The water begins to overflow an hour and a half prior to the eruption and is a good approximation of the actual geyser duration. The data table begins with an eruption in 2006 and then the 2007 data begins, that is why there is a 0:00:00 interval for the first interval in the data set, do not use the first line of data. The data table for 2007 looks like the following:

DATE	TIME	DURATION	DATE	TIME	INTERVAL
12/31/06	17:13:00	2:05:00	12/31/06	19:18:00	0:00:00
12/31/06	23:53:00	2:01:00	12/31/06	01:54:00	6:36:00
01/01/07	06:30:00	1:22:00	01/01/07	07:52:00	5:58:00

We will only be working with the duration and the interval data.



## RIVERSIDE GEYSER ERUPTIONS AND OVERFLOWS FOR THE FIRST 25 ERUPTIONS OF 2007

Overflow			Eruptions		
Date	Time	Duration	Date	Time	Interval
12/31/2006	23:53:00	2:01:00	1/1/2007	1:54:00	6:36:00
1/1/2007	6:30:00	1:22:00	1/1/2007	7:52:00	5:58:00
1/1/2007	12:18:00	2:03:00	1/1/2007	14:21:00	6:29:00
1/1/2007	19:00:00	2:04:00	1/1/2007	21:04:00	6:43:00
1/2/2007	1:38:00	2:03:00	1/2/2007	3:41:00	6:37:00
1/2/2007	8:13:00	2:06:00	1/2/2007	10:19:00	6:38:00
1/2/2007	14:45:00	1:58:00	1/2/2007	16:43:00	6:24:00
1/2/2007	21:10:00	1:56:00	1/2/2007	23:06:00	6:23:00
1/3/2007	3:35:00	1:54:00	1/3/2007	5:29:00	6:23:00
1/3/2007	10:01:00	1:57:00	1/3/2007	11:58:00	6:29:00
1/3/2007	16:31:00	1:56:00	1/3/2007	18:27:00	6:29:00
1/3/2007	22:55:00	1:54:00	1/4/2007	0:49:00	6:22:00
1/4/2007	5:22:00	1:53:00	1/4/2007	7:15:00	6:26:00
1/4/2007	11:51:00	1:52:00	1/4/2007	13:43:00	6:28:00
1/4/2007	18:19:00	1:59:00	1/4/2007	20:18:00	6:35:00
1/5/2007	0:50:00	2:01:00	1/5/2007	2:51:00	6:33:00
1/5/2007	7:24:00	2:05:00	1/5/2007	9:29:00	6:38:00
1/5/2007	14:02:00	2:06:00	1/5/2007	16:08:00	6:39:00
1/5/2007	20:39:00	2:05:00	1/5/2007	22:44:00	6:36:00
1/6/2007	3:14:00	1:55:00	1/6/2007	5:09:00	6:25:00
1/6/2007	9:41:00	1:56:00	1/6/2007	11:37:00	6:28:00
1/6/2007	16:13:00	2:04:00	1/6/2007	18:17:00	6:40:00
1/6/2007	22:55:00	2:07:00	1/7/2007	1:02:00	6:45:00
1/7/2007	5:36:00	1:21:00	1/7/2007	6:57:00	5:55:00
1/7/2007	11:20:00	2:04:00	1/7/2007	13:24:00	6:27:00

## 2. Graph paper or graphing calculator.

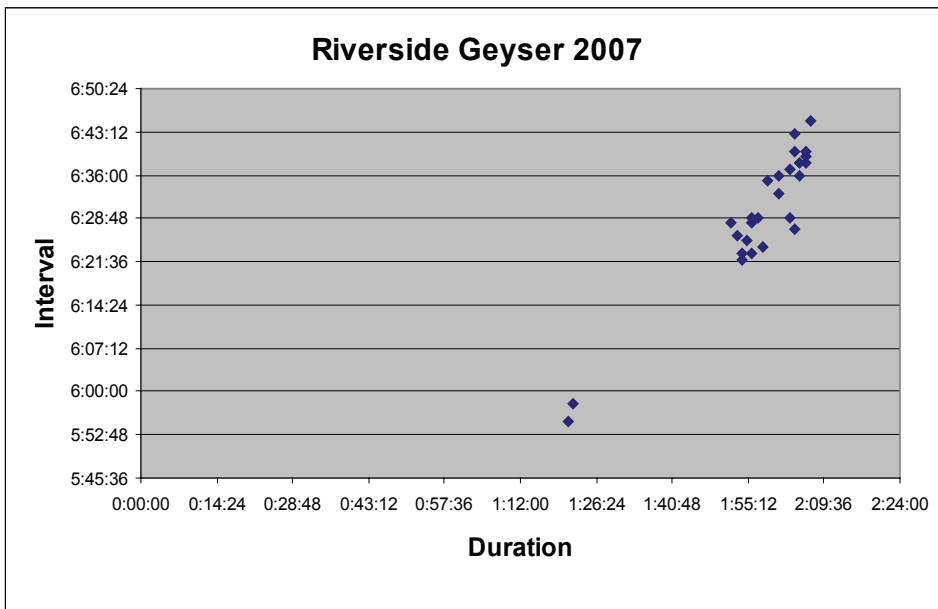
Anticipatory Set:

Showing a video clip of an eruption of Old Faithful (<http://www.nps.gov/archive/yell/insidyellowstone/0017oldfaithful3.htm>) or watching an eruption on the Old Faithful web cam (<http://www.nps.gov/archive/yell/oldfaithfulcam.htm>) will introduce and excite students about this activity. Ask the question, “What variables do you think would be needed in order to predict an eruption like Old Faithful geyser?”

## ACTIVITY OUTLINE:

1. If possible, show students the Riverside Geyser Study and Observation website (<http://www.geyserstudy.org/geyser.aspx?pGeyserNo=RIVERSIDE>) and the link to the Riverside eruption data.
2. Either have students obtain data for 100 eruptions of Riverside if they are using software or give the students a data set of the first 25 eruption for 2007 data.
3. Direct the students to generate a scatter plot of the two variables, placing the duration on the X axis and the interval on the Y axis. It really doesn't matter which is placed where, but this keeps it consistent. The graph should look like this: (*see next page*)





## RESOURCES:

<http://www.geyserstudy.org/default.htm> Geyser Observation and Study Association

<http://www.nps.gov/archive/yell/oldfaithfulcam.htm> Old Faithful Webcam

<http://www.nps.gov/archive/yell/insideyellowstone/videolist.htm> Short videos on geysers, videos 17,17a, 17b, 17c (1-2 minutes each)

4. Lead students in a discussion about the interpretation of the graph. Ask questions such as these:

- Does the graph show a linear relationship? YES
- Is there a particular grouping of data points? YES
- What do you notice about the groupings? ONE IS LOCATED NEAR THE BOTTOM LEFT OF THE GRAPH, THE OTHER AT THE UPPER RIGHT
- What do the groups tell you? THAT THE SHORTER THE DURATION OF AN ERUPTION, THE LESS TIME INTERVAL THERE WILL BE UNTIL THE NEXT ERUPTION. THE LONGER THE DURATION, THE GREAT TIME INTERVAL THERE WILL BE TO THE NEXT ERUPTION.
- Can you determine an average of the groupings? YES

5. Students should arrive at averages that are near 1:21 for short eruptions and 2:00 for long eruptions. The students should arrive at averages for the short interval near 5:56, and 6:32 for the long interval.

6. Students should note that there are very few eruptions between the groupings of data points, leading to the conclusion

that there are basically two eruptions of Riverside: short and long duration eruptions.

7. Using the graphic information can you predict the next eruption time? IT IS MORE LIKELY TO BE A LONG INTERVAL SO IT WOULD BE IN 6 HOURS AND 32 MINUTES. What are the chances of the next eruption being a short eruption? THERE IS AN 8% ( $2/25 = 0.08$ ) CHANCE THAT THE NEXT ERUPTION WOULD BE SHORT DURATION.

## CLOSURE AND ASSESSMENT:

1. Students will be assessed by correctly generating a graph based on the data provided. If they calculated intervals and duration tables, those can be assessed for accuracy.

2. Students can repeat this activity with other predictable geysers and test their model. See the Geyser Observation and Study Association website for eruption data on geyser such as Castle, Grand, Great Fountain or Spouter geysers.

