Yellowstone Eruption Analysis: A Study on the Relationship Between West Triplet and Rift Geysers

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Introduction

The West Triplet and Rift geysers are important members of the Grand Geyser Group, one of the most prominent geyser groups in Yellowstone National Park. The West Triplet and Rift geysers have been studied as possible influences on the intervals of Grand, although the relationship remains unclear. The Rift geyser erupts only after West Triplet has been active except when Rift is coming out of a dormant period. This research project examines the quantitative details of the relationship between the Rift and West Triplet Geysers using electronic data from 2003 to 2008.

Rift Geyser erupting. The height of the tallest jet rarely hit four feet.

Rift Geyser dormant.

The large geyser in the background is Grand Geyser, the largest predictive geyser known. The small geyser in front is West Triplet, part of the Grand group and may be influence Grand's eruptions. West Triplet has a maximum height of 10 feet, while Grand has been known to produce 180 foot jets.

The data was collected by electronic heat sensors and extracted by this man, Ralph Taylor, a thermal volunteer for Yellowstone National Park. This picture shows Taylor setting up a sensor to put under the boardwalk in West Triplet's runoff channel.

Methods

The eruptions analyzed in this study occurred between 1/1/2003 and 11/6/2008. The dates of endpoints were determined by the available data on the Geyser Observation and Study Association (GOSA) website. The data was downloaded from the website then sorted to determine the times both West Triplet and Rift were recorded. Harsh weather conditions and equipment failure resulted in 884 eruptions of West Triplet and 273 Rift eruptions being excluded because there was no data for those times in the other geyser. Eight periods of continuous data were identified and given in the below table.

Years of Study

Year(s)	Start	End	# days	# WT	# R
2003a	1/1/2003 0:00:00	1/23/2003 5:36:24	22.2	83	35
2003b	2/1/2003 19:57:59	4/10/2003 1:57:59	67.3	226	103
03-04	5/2/2003 21:18:46	9/15/2004 11:36:20	501.6	1885	768
04-05	9/19/2004 21:56:00	4/2/2005 12:49:31	194.6	722	325
2005	6/28/2005 2:37:00	12/9/2005 16:02:00	164.6	640	320
05-06	12/9/2005 23:44:00	2/16/2006 7:17:00	68.3	257	127
06-08	6/13/2006 0:27:00	1/15/2008 3:59:00	581.1	2591	1249
2008b	5/27/2008 23:34:00	11/6/2008 9:24:00	162.4	584	257
		Total	1762.1	6988	3184

For analysis, basic descriptive statistics were gathered for each geyser on each period on the duration of eruption and the intervals between eruptions. Then the West Triplet eruptions were sorted into two categories: those that were followed by a Rift eruption and those that were not. The time between the start of the West Triplet Geyser and the Rift Geyser were also computed to determine if the Rift eruptions followed those of West Triplet. Lastly, the numbers of West Triplet eruptions following a Rift eruption were calculated and sorted. Basic descriptive statistics were found on each of these sorted groups to determine if any of this information had an effect on a time between Rift and West Triplet eruptions.

Results

Basic statistics for West Triplet intervals, West Triplet durations, Rift intervals, and Rift Durations are given below. Boxplots of West Triplet and Rift Intervals are further down.

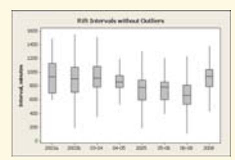
Intervals-Rift	2003a	2003b	03-04	04-05	2005	05-06	06-08	2008
Count	35	103	768	325	320	127	1249	257
Minimum	9:50:00	3:05:00	4:20:00	1:50:00	1:09:00	1:29:00	1:20:00	1:38:00
5th Percentile	10:38:30	10:50:30	10:04:42	9:05:00	7:04:45	7:59:30	5:18:00	9:18:24
1st Quartile	11:35:00	11:45:00	13:04:15	12:58:30	9:58:30	10:04:30	8:53:00	13:10:00
Median	15:35:00	15:05:00	15:19:30	14:15:00	13:00:00	13:03:00	11:00:00	15:40:00
3rd Quartile	18:45:00	17:50:00	18:02:00	15:48:00	14:42:30	14:16:00	13:34:00	17:16:00
95th Percentile	23:05:00	23:57:00	22:04:47	20:54:24	16:34:09	17:19:06	16:38:24	20:44:36
Maximum	24:55:00	40:55:00	64:58:00	30:55:00	22:11:00	23:31:00	23:29:00	26:38:00
90% Range	12:26:30	13:06:30	12:00:05	11:49:24	9:29:24	9:19:36	11:20:24	11:26:12
IQR	7:10:00	6:35:00	4:57:45	2:49:30	4:44:00	4:11:30	4:41:00	4:06:00
Range	15:05:00	37:50:00	60:38:00	29:05:00	21:02:00	22:02:00	22:09:00	25:00:00
Mean	15:35:00	15:37:36	15:40:53	14:23:24	12:22:12	12:20:22	11:10:29	15:13:07
Standard Dev	4:06:30	5:06:18	4:27:00	3:44:12	3:26:09	3:24:25	3:31:17	3:44:38
Coef of Var	0.2637	0.3267	0.2838	0.2596	0.2777659	0.27611	0.315129	0.246017

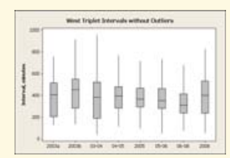
Durations-WT	2003a	2003b	03-04	04-05	2005	05-06	06-08	2008
Count	83	226	1885	722	640	257	2591	584
Minimum	0:18:00	0:00:00	0:02:00	0:14:00	0:06:00	0:05:00	0:01:00	0:03:00
5th Percentile	0:24:00	0:27:00	0:14:00	0:25:03	0:22:00	0:18:00	0:18:00	0:26:00
1st Quartile	0:27:00	0:33:00	0:26:00	0:30:00	0:31:00	0:30:00	0:27:00	0:32:00
Median	0:33:00	0:39:00	0:32:00	0:35:00	0:37:00	0:35:00	0:34:00	0:36:00
3rd Quartile	0:54:00	0:57:00	0:48:00	0:50:00	0:52:00	0:49:00	0:51:00	0:54:00
95th Percentile	1:00:00	1:06:00	1:00:00	0:58:00	0:59:03	0:55:00	0:59:00	1:04:00
Maximum	1:09:00	1:12:00	1:12:00	1:09:00	1:10:00	1:05:00	1:12:00	1:14:00
90% Range	0:36:00	0:39:00	0:46:00	0:32:57	0:37:03	0:37:00	0:41:00	0:38:00
IQR	0:27:00	0:24:00	0:22:00	0:20:00	0:21:00	0:19:00	0:24:00	0:22:00
Range	0:51:00	1:12:00	1:10:00	0:55:00	1:04:00	1:00:00	1:11:00	1:11:00
Mean	0:39:35	0:43:51	0:35:41	0:39:24	0:40:29	0:38:11	0:37:45	0:41:42
Standard Dev	0:13:32	0:14:23	0:14:08	0:11:20	0:12:24	0:12:20	0:13:31	0:13:24
Coef of Var	0.342	0.328	0.3962	0.2878	0.306334	0.322974	0.357916	0.321142

Intervals-WT	2003a	2003b	03-04	04-05	2005	05-06	06-08	2008
Count	83	226	1885	722	640	257	2591	584
Minimum	2:06:00	2:12:00	0:38:00	1:54:00	1:35:00	0:52:00	1:14:00	0:53:00
5th Percentile	2:33:18	2:45:00	2:24:00	2:27:00	2:18:00	2:26:00	1:56:00	2:35:09
1st Quartile	3:27:00	4:44:18	3:10:00	4:45:45	4:54:00	4:43:00	3:59:00	3:55:45
Median	6:48:00	7:34:30	6:26:00	6:34:00	6:06:00	5:54:00	5:13:00	6:42:00
3rd Quartile	8:36:00	9:09:48	8:40:45	8:00:15	7:45:15	7:43:00	6:57:00	8:53:15
95th Percentile	11:24:54	11:12:00	11:22:00	11:05:48	9:32:18	9:52:24	8:54:00	11:29:57
Maximum	12:39:00	19:30:00	18:48:00	27:41:00	13:35:00	12:39:00	14:06:00	13:49:00
90% Range	8:51:36	8:27:00	8:58:00	8:38:48	7:14:18	7:26:24	6:58:00	8:54:48
IQR	5:09:00	4:25:30	5:30:45	3:14:30	2:51:15	3:00:00	2:58:00	4:57:30
Range	10:33:00	17:18:00	18:10:00	25:47:00	12:00:00	11:47:00	12:52:00	12:56:00
Mean	6:25:48	7:10:24	6:23:17	6:28:11	6:11:06	6:07:08	5:23:05	6:40:45
Standard Dev	2:54:06	2:53:06	3:04:19	2:38:53	2:12:32	2:12:35	2:09:31	2:54:42
Coef of Var	0.4514	0.4022	0.4809	0.4093	0.357136	0.361111	0.400883	0.435934

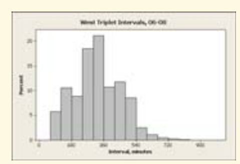
Durations-Rift	2003a	2003b	03-04	04-05	2005	05-06	06-08	2008
Count	35	103	768	325	320	127	1249	257
Minimum	0:30:00	0:05:00	0:02:00	0:01:00	0:01:00	0:04:00	0:01:00	0:01:00
5th Percentile	0:38:30	0:30:30	0:38:00	0:33:00	0:21:54	0:26:54	0:14:00	0:26:24
1st Quartile	0:50:00	0:50:00	0:52:15	0:48:00	0:44:00	0:40:30	0:27:00	0:51:00
Median	1:00:00	1:05:00	1:21:00	1:07:00	1:05:00	0:54:00	0:42:00	1:09:00
3rd Quartile	1:30:00	1:25:00	1:44:00	1:27:30	1:31:15	1:20:30	1:10:00	1:28:00
95th Percentile	2:00:00	2:14:00	3:12:00	2:04:00	2:25:15	1:57:24	1:56:12	1:55:00
Maximum	2:05:00	3:20:00	6:04:00	2:57:00	5:55:00	3:36:00	3:02:00	2:43:00
90% Range	1:21:30	1:43:30	2:34:00	1:31:00	2:03:21	0.062847	0.070972	0.061528
IQR	0:40:00	0:35:00	0:51:45	0:39:30	0:47:15	0:40:00	0:43:00	0:37:00
Range	1:35:00	3:15:00	6:02:00	2:56:00	5:54:00	3:32:00	3:01:00	2:42:00
Mean	1:09:26	1:09:10	1:28:00	1:10:38	1:13:05	1:02:43	0:50:58	1:09:32
Standard Dev	0:24:35	0:33:10	0:48:38	0:29:53	0:44:07	0:32:01	0:32:16	0:28:31
Coef of Var	0.354	0.4794	0.5526	0.423	0.603501	0.510349	0.632982	0.410074

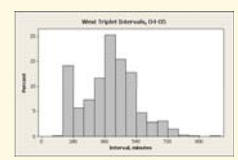
Intervals for West Triplet and Rift are highly variable during any given period. However, both geysers followed a similar behavior. In 2003a, 2003b, 03-04, 04-05 both West Triplet and Rift had steady interval times, then in 05b-06a both geyser intervals dropped significantly. In 2008b the interval time increased back to the original 2003-2005 level.





The histograms of West Triplet have two forms: unimodal and bimodal. The bimodal histograms correspond to intervals 2003a, 2003b, 03-04, 04-05, and 2008b, the same set of intervals with steady interval times. Below are examples of the unimodal and bimodal histograms.





Rift Geyser will only erupt after a West Triplet Geyser eruption, unless it is coming out of dormancy. However, Rift does not follow every West Triplet eruption. We separated West Triplet eruptions into those who precede a Rift eruption and those who do not. Below shows the differences in interval and duration of West Triplet eruptions between the two categories.