

YELLOWSTONE GEYSER OBSERVATIONS

George D. Marler

Volume 4

Contents

Hot Spring Activity in the Firehole Geyser Basins 1964
Hot Spring Activity in the Firehole Geyser Basins 1967
Hot Spring Activity in the Firehole Geyser Basins 1968
Hot Spring Activity in the Firehole Geyser Basins 1969
Hot Spring Activity in the Firehole Geyser Basins 1970

551.23
M 347
YELLOWSTONE
NATIONAL PARK
LIBRARY

10309

1964

**Hot Spring Activity In The Geyser Basins Of The
Firehole River For the 1964 Season**

George D. Marler

During 1964, geyser activity was known to occur in the following named springs:

UPPER BASIN

Giantess Group

- | | | |
|-------------------------|----------------------|---------------------|
| 1. Little Squirt Geyser | 8. Lion Geyser | 15. Vault Geyser |
| 2. Anemone Geyser | 9. Little Cub Geyser | 16. Giantess Geyser |
| 3. Surge Geyser | 10. Goggle Spring | 17. Infant Geyser |
| 4. Roof Geyser | 11. N. Goggle Spring | 18. Solitary Geyser |
| 5. Plume Geyser | 12. Beach Spring | 19. Bench Geyser |
| 6. Beehive Geyser | 13. Aurum Geyser | |
| 7. Depression Geyser | 14. Sponge Geyser | |

Myriad Group

Three Sisters:

- | | | |
|------------------|-------------------|-----------------|
| 1. North Crater | 3. Little Brother | 5. White Geyser |
| 2. Middle Crater | 4. Round Geyser | |

Black Sand Basin

- | | |
|--------------------|--------------------|
| 1. Spouter Geyser | 3. Cliff Geyser |
| 2. Cucumber Spring | 4. Black Sand Pool |

Daisy Group

- | | | |
|-----------------|------------------|-------------------|
| 1. Daisy Geyser | 3. Daisy's Thief | 5. Pyramid Throne |
| 2. Comet Geyser | 4. Bank Geyser | |

Old Faithful Group

1. Old Faithful

Lone Star Group

1. Lone Star Geyser

Castle & Sawmill Groups

1. Castle Geyser
2. Tilt Geyser
3. Deleted Teakettle
4. Sawmill Geyser

5. Penta Geyser
6. Spasmodic Geyser
7. Tardy Geyser
8. Bulger Geyser

9. Sprinkler Geyser
10. Churn Geyser
11. Terra Cotta Springs
12. Spanker Geyser

Grand Group

1. Grand Geyser
2. Turban Geyser

3. Vent Geyser
4. Rift Geyser

5. W. Triplet Geyser
6. Witches Cauldron

Round Spring Group

1. Round Spring Geyser

2. Pear Geyser

Giant Group

1. Bijou Geyser

2. Oblong Geyser

Grotto Group

1. Grotto Geyser
2. Rocket Geyser
3. Spa Geyser

4. Surprise Geyser
5. South Surprise Geyser

6. Link Geyser
7. Riverside Geyser

Morning Glory Group

1. Fan and Mortar

2. Sentinel Geyser

3. Spiteful Geyser

Cascade Group

1. Artemisia Geyser
2. Atomizer Geyser

3. Seismic Geyser

4. Hillside Geyser

Biscuit Basin

1. Cauliflower Geyser
2. Sapphire Pool
3. Shell Geyser

4. Jewel Geyser
5. Avoca Geyser
6. Coral Geyser

7. Black Pearl Geyser
8. E. Mustard Spring
9. W. Mustard Spring

MIDWAY BASIN

1. Catfish Geyser
2. Tromp Spring

3. E. Flood Geyser

4. W. Flood Geyser

LOWER BASIN

Great Fountain Area

- | | | |
|--------------------------|----------------------|------------------|
| 1. Great Fountain Geyser | 2. White Dome Geyser | 3. Gemini Geyser |
|--------------------------|----------------------|------------------|

Pink Cone Group

- | | | |
|---------------------|---------------------|---------------|
| 1. Pink Cone Geyser | 3. Narcissus Geyser | 4. Box Spring |
| 2. Bead Geyser | | |

Firehole Lake Area

- | | |
|------------------|-------------------------|
| 1. Steady Geyser | 2. Young Hopeful Geyser |
|------------------|-------------------------|

Fountain Group

- | | | |
|---------------------|----------------|--------------------|
| 1. Clepsydra Geyser | 4. Sub Geyser | 7. Twig Geyser |
| 2. Spasm Geyser | 5. Red Spouter | 8. Fountain Geyser |
| 3. Jelly Geyser | 6. Mask Geyser | |

Hotel Group

- | | | |
|------------------|-----------------|-------------------|
| 1. Kidney Geyser | 2. Cliff Spring | 3. Stirrup Spring |
|------------------|-----------------|-------------------|

Kaleidoscope Group

- | | | |
|------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
|------------------------|---------------------|---------------------|

River Group

- | | | |
|----------------|-----------------|--------------------|
| 1. Bath Spring | 2. Mound Geyser | 3. Fortress Geyser |
|----------------|-----------------|--------------------|

Sentinel Creek Area

1. Rosette Geyser

Morning Mist Group

1. Morning Mist Geyser

Following each group name, the number of hot springs in that group that showed geyser activity is listed:

- | | | | |
|------------------------|---|-----------------------|---|
| 1. Lone Star Group | 3 | 7. Round Spring Group | 1 |
| 2. Giantess Group | 4 | 8. Grotto Group | 1 |
| 3. Myriad Group | 3 | 9. Cascade Group | 6 |
| 4. Black Sand Basin | 1 | 10. Biscuit Basin | 3 |
| 5. Castle & Sawmill | 4 | 11. Rabbit Creek | 3 |
| | | 12. Great Fountain | 2 |
| 6. Orange Spring Group | 2 | 13. Pink Cone Group | 4 |
| | | 14. Firehole Lake | 1 |
| | | 15. Fountain Group | 3 |
| | | 16. Kaleidoscope | 6 |
| | | 17. Pithole Springs | 8 |
| | | 18. River Group | 3 |
| | | 19. Camp Group | 2 |

Comparative temperatures for the month of September 1963 and 1964. All temperatures are Fahrenheit readings.

<u>Geyser Hill</u>		<u>1963</u>	<u>1964</u>
1.	Sylphide Spring	174	182
2.	Bronze Spring	195	160
3.	Silver Spring	200	202
4.	Little Squirt Geyser	200	200
5.	Anemone, N. Vent	194	194
6.	Anemone, S. Vent	200	200
7.	Cascade Geyser	191	181
8.	Surge Geyser	202	200
9.	Plume Geyser	189	189
10.	Beehive Geyser	201	205
11.	Scissors Spring	192	198
12.	Blowout Spring	180	178
13.	Arrowhead Spring	174	175
14.	Depression Geyser	185	185
15.	Heart Spring	198	176
16.	Little Cub Geyser	200	200
17.	Lioness Geyser	202	202
18.	Big Cub Geyser	202	202
19.	Lion Geyser	202	201
20.	South Goggle Spring	198	198
21.	North Goggle Spring	194	197
22.	Ear Spring	200	200
23.	Pendant Spring	197	185
24.	Beach Spring	200	196
25.	Aurum Geyser	201	202
26.	East Doublet Pool	192	183
27.	West Doublet Pool	191	177
28.	Sponge Geyser	202	202
29.	Pump Geyser	200	200
30.	Model Geyser	200	200
31.	Dragon Spring	181	165
32.	Roof Geyser	199	200
33.	Teakettle Spring	201	202
34.	Giantess Geyser	202	200
35.	Vault Geyser	196	195
36.	Infant Geyser	200	199
37.	Dome Geyser	190	184
38.	Rock Pool	197	199

The average 1964 temperature was 106 degrees lower than the average 1963 temperature.

Old Faithful Group

	<u>1963</u>	<u>1964</u>
1. Blue Star Spring	186	183
2. Chinaman Spring	200	200
3. E. Chinaman Spring	199	198
4. Fumarole Cone	201	201
5. Old Faithful	200	200
		Loss of 4 degrees

Myriad Group

1. White Geyser	196	200
2. Lactose Spring	184	177
3. Round Geyser	176	183
4. Myriad Geyser	199	198
5. Bell Geyser	162	163
6. Trail Geyser	196	176
7. West Trail Geyser	199	167
8. Little Brother	202	202
9. Pink Cistern	186	186
		Loss of 49 degrees

Black Sand Basin

1. Whistle Geyser	145	162
2. Spouter Geyser	201	201
3. Black Sand Opal	77	77
4. Cucumber Spring	195	188
5. Cucumber Spouter	198	194
6. Green Spring	173	173
7. Emerald Pool	147	147
8. Handkerchief Pool	170	150
9. Rainbow Pool	170	154
10. Cliff Geyser	195	195
11. Black Sand Pool	199	198
12. Punch Bowl	202	202
		Loss of 31 degrees

Daisy Group

1. Daisy Geyser	199	200
2. Comet Geyser	202	202
3. Brilliant Pool	201	201
4. Splendid Geyser	201	200
5. Daisy's Thief	200	201
6. Murky Spring	158	180
7. Bonita Pool	199	200
8. Radiator Geyser	199	201
9. Bank Geyser	199	200
		Gain of 27 degrees

Grand Group

	<u>1963</u>	<u>1964</u>
1. Chimney Cone	200	198
2. South Scalloped Spring	200	197
3. Scalloped Spring	200	200
4. Deleted Teakettle	201	200
5. Churn Geyser	175	172
6. Sawmill Geyser	198	198
7. Tardy Geyser	197	197
8. Spasmodic South Vent	202	200
9. Penta Geyser	202	201
10. Bulger Geyser	200	200
11. Belgian Pool	167	157
12. Liberty Pool	190	191
13. Frog Pool	185	177
14. West Frog Pool	187	190
15. West Triplet	191	188
16. Grand Geyser	175	175
17. Turban Geyser	198	198
18. Vent Geyser	182	178
19. Rift Geyser	190	190
20. Economic Geyser	150	154
21. East Economic	139	147
22. Beauty Pool	167	168
23. Chromatic Spring	188	177
24. Wave Spring	177	178
25. Calida Pool	190	186
26. Milk Spring	200	200
27. Witches Cauldron	201	202
28. Lime Kiln	201	201

Loss of 33 degrees

Castle Group

1. Castle Geyser	200	200
2. Tortoise Shell Spring	205	205
3. Tilt Geyser	170	168
4. Crested Pool	175	182
5. Sprinkler Geyser	200	200
6. Slag Cone	200	198
7. Terra Cotta Spring	200	199
8. Spanker Geyser	200	200

Gain of 2 degrees

Round Spring Group

1. Round Spring	167	137
2. North Round Spring	140	143
3. Round Spring Geyser	194	200
4. Pear Spring	157	145
5. West Round Spring	159	155

Loss of 27 degrees

Giant Group

	1963	1964
1. Giant Geyser	203	204
2. Mastiff Geyser	203	202
3. Catfish Geyser	200	200
4. Turtle Geyser	196	194
5. South Purple Pool	164	155
6. East Purple Pool	200	200
7. North Purple Pool	200	200
8. Oblong Geyser	199	199
9. Inkwell Spring	200	201
		Loss of 10 degrees

Grotto Group

1. Grotto Geyser	202	202
2. Rocket Geyser	202	202
3. Indicator Spring	141	143
4. Surprise Geyser	188	188
5. South Surprise Geyser	198	199
6. Spa Geyser	194	192
7. Riverside Geyser	200	200
		Gain of 1 degree

Chain Lake Group

1. Culvert Geyser	200	198
2. Square Spring	187	188
3. Bottomless Spring	146	141
4. Link Geyser	201	201
5. Cyclops Spring	185	186
		Loss of 5 degrees

Morning Glory Group

1. Morning Glory Pool	162	157
2. Mortar Geyser, South Vent	200	201
3. Mortar Geyser, North Vent	201	201
4. Spiteful Geyser	200	203
5. East Sentinel Geyser	200	200
6. West Sentinel Geyser	200	200
		Loss of 1 degree

Cascade Group

1. Bench Spring	201	200
2. Iron Spring	177	180
3. Artemisia Geyser	193	193
4. Atomizer Geyser	200	200
5. Gem Pool	174	163
6. Sprite Spring	166	173

LOWER BASIN

Great Fountain Area

- | | | |
|--------------------------|----------------------|------------------|
| 1. Great Fountain Geyser | 2. White Dome Geyser | 3. Gemini Geyser |
|--------------------------|----------------------|------------------|

Pink Cone Group

- | | | |
|---------------------|---------------------|---------------|
| 1. Pink Cone Geyser | 3. Narcissus Geyser | 4. Box Spring |
| 2. Bead Geyser | | |

Firehole Lake Area

- | | |
|------------------|-------------------------|
| 1. Steady Geyser | 2. Young Hopeful Geyser |
|------------------|-------------------------|

Fountain Group

- | | | |
|---------------------|----------------|--------------------|
| 1. Clepsydra Geyser | 4. Sub Geyser | 7. Twig Geyser |
| 2. Spasm Geyser | 5. Red Spouter | 8. Fountain Geyser |
| 3. Jelly Geyser | 6. Mask Geyser | |

Hotel Group

- | | | |
|------------------|-----------------|-------------------|
| 1. Kidney Geyser | 2. Cliff Spring | 3. Stirrup Spring |
|------------------|-----------------|-------------------|

Kaleidoscope Group

- | | | |
|------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
|------------------------|---------------------|---------------------|

River Group

- | | | |
|----------------|-----------------|--------------------|
| 1. Bath Spring | 2. Mound Geyser | 3. Fortress Geyser |
|----------------|-----------------|--------------------|

Sentinel Creek Area

1. Rosette Geyser

Morning Mist Group

1. Morning Mist Geyser

Following each group name, the number of hot springs in that group that showed geyser activity is listed:

- | | | | |
|------------------------|---|-----------------------|---|
| 1. Lone Star Group | 3 | 7. Round Spring Group | 1 |
| 2. Giantess Group | 4 | 8. Grotto Group | 1 |
| 3. Myriad Group | 3 | 9. Cascade Group | 6 |
| 4. Black Sand Basin | 1 | 10. Biscuit Basin | 3 |
| 5. Castle & Sawmill | 4 | 11. Rabbit Creek | 3 |
| | | 12. Great Fountain | 2 |
| 6. Orange Spring Group | 2 | 13. Pink Cone Group | 4 |
| | | 14. Firehole Lake | 1 |
| | | 15. Fountain Group | 3 |
| | | 16. Kaleidoscope | 6 |
| | | 17. Pithole Springs | 8 |
| | | 18. River Group | 3 |
| | | 19. Camp Group | 2 |

Old Faithful Group

	<u>1963</u>	<u>1964</u>
1. Blue Star Spring	186	183
2. Chinaman Spring	200	200
3. E. Chinaman Spring	199	198
4. Fumarole Cone	201	201
5. Old Faithful	200	200
		Loss of 4 degrees

Myriad Group

1. White Geyser	196	200
2. Lactose Spring	184	177
3. Round Geyser	176	183
4. Myriad Geyser	199	198
5. Bell Geyser	162	163
6. Trail Geyser	196	176
7. West Trail Geyser	199	167
8. Little Brother	202	202
9. Pink Cistern	186	186
		Loss of 49 degrees

Black Sand Basin

1. Whistle Geyser	145	162
2. Spouter Geyser	201	201
3. Black Sand Opal	77	77
4. Cucumber Spring	195	188
5. Cucumber Spouter	198	194
6. Green Spring	173	173
7. Emerald Pool	147	147
8. Handkerchief Pool	170	150
9. Rainbow Pool	170	154
10. Cliff Geyser	195	195
11. Black Sand Pool	199	198
12. Punch Bowl	202	202
		Loss of 31 degrees

Daisy Group

1. Daisy Geyser	199	200
2. Comet Geyser	202	202
3. Brilliant Pool	201	201
4. Splendid Geyser	201	200
5. Daisy's Thief	200	201
6. Murky Spring	158	180
7. Bonita Pool	199	200
8. Radiator Geyser	199	201
9. Bank Geyser	199	200
		Gain of 27 degrees

Giant Group

	<u>1963</u>	<u>1964</u>
1. Giant Geyser	203	204
2. Mastiff Geyser	203	202
3. Catfish Geyser	200	200
4. Turtle Geyser	196	194
5. South Purple Pool	164	155
6. East Purple Pool	200	200
7. North Purple Pool	200	200
8. Oblong Geyser	199	199
9. Inkwell Spring	200	201
	Loss of 10 degrees	

Grotto Group

1. Grotto Geyser	202	202
2. Rocket Geyser	202	202
3. Indicator Spring	141	143
4. Surprise Geyser	188	188
5. South Surprise Geyser	198	199
6. Spa Geyser	194	192
7. Riverside Geyser	200	200
	Gain of 1 degree	

Chain Lake Group

1. Culvert Geyser	200	198
2. Square Spring	187	188
3. Bottomless Spring	146	141
4. Link Geyser	201	201
5. Cyclops Spring	185	186
	Loss of 5 degrees	

Morning Glory Group

1. Morning Glory Pool	162	157
2. Mortar Geyser, South Vent	200	201
3. Mortar Geyser, North Vent	201	201
4. Spiteful Geyser	200	203
5. East Sentinel Geyser	200	200
6. West Sentinel Geyser	200	200
	Loss of 1 degree	

Cascade Group

1. Bench Spring	201	200
2. Iron Spring	177	180
3. Artemisia Geyser	193	193
4. Atomizer Geyser	200	200
5. Gem Pool	174	163
6. Sprite Spring	166	173

Cascade Group (continued)

	<u>1963</u>	<u>1964</u>
7. Calthos Spring	178	174
8. Pulcher Spring	195	191
9. Hillside Geyser	202	200
10. Seismic Geyser	200	205
11. Baby Daisy Geyser	180	173
12. Biscuit Basin Geyser	200	200
	Loss of 14 degrees	

Biscuit Basin

1. Mirror Pool	183	183
2. Cauliflower Geyser	187	187
3. Black Opal Pool	130	132
4. Wall Pool	107	107
5. Sapphire Pool	202	201
6. Shell Geyser	199	201
7. Jewel Geyser	195	190
8. Silver Globe Spring	197	194
9. Avoca Spring	202	202
10. West Spring	176	176
11. Spicule Spring	156	156
12. Fumarole Geyser	198	201
13. West Mustard Spring	199	198
14. East Mustard Spring	199	195
15. North Geyser	198	198
16. Coral Geyser	200	198
17. Black Pearl Geyser	197	196
	Loss of 10 degrees	

Midway Basin

1. Mud Spring	194	194
2. Tire Spring	153	152
3. Catfish Geyser	202	202
4. Flood Geyser	202	202
5. West Flood Geyser	199	199
6. Tromp Spring	194	193
7. Indigo Spring	200	200
8. Opal Pool	186	185
9. Turquoise Pool	95	60
10. Excelsior Geyser	199	199
	Loss of 38 degrees	

Firehole Lake Loop Road

1. Lemon Spring	130	132
2. Broken Egg Spring	162	119
3. Firehole Pool	193	192

Firehole Lake Loop Road (continued)

	<u>1963</u>	<u>1964</u>
4. Surprise Pool	201	203
5. Great Fountain	202	202
6. White Dome Geyser	200	200
7. Gemini Geyser	200	200
8. Pink Cone Geyser	200	201
9. Bead Geyser	199	199
10. Shelf Spring	202	202
11. Narcissus Geyser	183	185
12. Zomar Spring	163	165
13. Firehole Lake, East Side	140	141
14. Flame Pool	173	173
15. Steady Geyser	200	200
16. Salfosel Spring	196	196
17. Black Warrior Spring	189	183

Loss of 40 degrees

Fountain Group

1. Silex Spring	195	191
2. Fountain Paint Pot	200	200
3. Red Spouter	200	200
4. Leather Pool	170	175
5. Cone Spring	198	198
6. Jet Geyser	203	200
7. Morning Geyser	142	144
8. Fountain Geyser	190	200
9. Spasm Geyser	201	202
10. Jelly Geyser	207	206
11. Clepsydra	202	202
12. Sub Geyser	200	201
13. Gore Spring	158	158
14. Clepsydra Well	195	194
15. Bellefontaine Geyser	198	194
16. Celestine Pool	198	192

Average Temperature same

Sprinkler Group

1. Gentian Pool	179	178
2. Earthquake Geyser	202	201
3. Steam Vent	202	201
4. Bridge Geyser	202	200
5. Sprinkler Geyser	198	198

Loss of 5 degrees

Kaleidoscope Group

	<u>1963</u>	<u>1964</u>
1. Honeycomb Geyser	180	180
2. Big Blue Geyser	199	198
3. Kaleidoscope Geyser	200	200
4. Deleted Surprise	180	181
Average Temperature same		

Hotel Group

1. Fungoid Spring	196	196
2. Stirrup Spring	190	191
3. Gourd Spring	186	176
4. Cliff Spring	195	195
5. Oak Leaf Spring	198	198
6. Kidney Spring	199	198
7. Thud Geyser	182	175
8. Jug Spring	173	175
9. Round Spring	128	127

Loss of 16 degrees

River Group

1. Skeleton Pool	188	188
2. Mound Geyser	200	199
3. Grotton Spring	196	197
4. Cavern Spring	198	197
5. Bath Spring	201	201
6. Cone Spring	195	196
7. Horn Spring	168	168

Average Temperature same

in very infrequent geyser activity of Beach. Pendant discharged about 3 gallons per minute and Doublet about 5. Both springs overflowed constantly with no apparent variation in volume of discharge.

Sponge, Pump and Roof Geysers performed essentially the same as during 1963. Water in Dragon Spring remained at the level it was dropped to by the 1959 earthquake.

Giantess Complex: No eruptions of Giantess occurred between May 1 and October 30, the period it was under observation. Water boiled constantly in its big crater, but no degree of boiling was observed suggesting pre-eruption symptoms.

An eruption of Giantess in November, 1963 ruptured a section of the scalloped border on the east side of the crater. The break was extensive enough that it resulted in an alteration of the direction of quiet-phase overflow. The ruptured border lowered the water level about 1 inch. However, the reduced hydrostatic pressure was not sufficient to bring about an eruption. This in part could have been due to the great amount of activity of Vault. During most of the season, until late in the summer, it erupted every 45 minutes to an hour. During the season the temperature of Giantess was consistently about 2 degrees lower than in 1963.

At the time of an eruption of Giantess the crater of Teakettle Spring empties, refilling simultaneously with Giantess and Vault. However, since the mid-forties Teakettle has failed to refill to overflow level. There has been a slow and progressive ebb in its water level, which now stands 45 inches below the top of the bowl.

Infant Geyser was in a state of overflow all season, but no eruption was observed. As during all previous seasons, this spring is the recipient of a great amount of vandalism. The same is also true of nearby Rock Pool, whose crater is now filled with tourist introduced rubble. Dome Geyser overflowed constantly, about 1/2 gallon per minute, but no eruption occurred. This was probably due to a 6 degree drop in temperature.

Myriad Group

Due to its location behind the Old Faithful Inn, this interesting group of springs is somewhat isolated from the rest of the basin and infrequently visited by tourists. The same cannot be said of concession employees. This latter group has been guilty of extreme vandalism over the years.

Most of the springs in the group have no discharge and their water is murky. There are a few small mud pots, the largest of which is Pink Cistern. This mud spring came into being following the 1959 earthquake.

The temperature of a number of the springs in this group declined from 1963 readings. This was especially true of Trail and West Trail Geysers.

the increase in activity during 1964 was the result of the temperature increase. However, the cause of the higher temperature in Beehive is not readily apparent. There is a high degree of probability that the increase in temperature resulted from a shift of thermal energy from a spring or springs (as yet unknown) with which Beehive has underground connections. In the great majority of cases where there is increase or decrease in geyser activity it is readily explicable by a shift of the thermal energy to or from a spring known to be subterraneously connected with the geyser under question.

Depression Geyser: This geyser was so named because of the depressed appearance of the crater which is situated on the slope of an older sinter. During 1964 Depression erupted with some regularity; the intervals varied between 3 and 4 hours; the duration from 2 to 3 minutes; the height 8 to 10 feet.

There was no observed geyser activity in the small vents between Depression and Arrowhead Springs. Both Arrowhead and Heart Springs overflowed constantly, Arrowhead discharging about $3/4$ of a gallon per minute and Heart about 2.

Lion Complex: During the 1964 season Lion Geyser erupted with greater frequency than during any season since 1957. In 1964, from May 1 to October 30, 108 eruptions were recorded. During the comparable period in 1963, but 20 eruptions were noted.

Lion is a cone-type geyser in both structure and function, but it has one characteristic common to fountain-type geysers, in that an active phase consists of several separate bursts of water. During 1964 some of Lion's active phases would last for as long as 3 days, the eruptions occurring about every 1 to 2 hours. It would go into an active phase every 5 to 7 days. During 1964 thirty-two active phases were recorded. Prior to the 1958 season, the active phases recurred about every 3 days, lasting for about 36 hours; the intervals being essentially the same as during its 1964 rejuvenation.

The temperature of Lioness and Big Cub Geysers shows a great deal of constancy year after year, being about 202 degrees. The water in the crater of Lioness stood 30 inches below the rim of the bowl all season.

The Goggles are situated at the base of the Lion Complex. The south vent is intermittent in its overflow. At the time of overflow there is no boiling. This overflow is the main source of supply for the Goggle whose crater is filled with algae. North Goggle is situated about 20 feet northeast of the Goggles. Since the 1959 earthquake, it has been having occasional eruptions. Two were observed in 1964.

During 1964, Ear Spring was in essentially the same state as during 1963. However, temperatures were lower in Pendant and Beach Springs than in 1963. The same was true of Doublet Pool. Lower temperature resulted

improbable that temperatures would be reverting to and below pre-quake conditions so quickly. The increase in temperature and geyser activity apparently resulted from fractures in surficial rocks, tapping the steam potential resident in these rocks. If this conjecture is true, present data support it, further overall decrease in temperature can be expected.

Geyser Hill-30

With the exception of Bronze Spring and Cascade Geyser the function of the hot springs near the junction of the walk was essentially the same in 1964 as in 1963. The most noted differences were in the above named springs. The temperature of Cascade dropped 10 degrees while that of Bronze dropped 35 degrees. This was partially compensated by a rise of 8 degrees in Sulphide Springs. The water level in Bronze was about a foot lower than in 1963. Little Squirt is becoming less frequent in its activity.

Anemone Geyser: Anemone's post-earthquake pattern is persisting. The profuse growth of algae in the overflow channel of the south vent is indicative of discharge most of the time. After occasional pauses it is stimulated into an eruption by activity in the north vent.

Plume Geyser: Plume continued to erupt with the marked regularity which characterized it during 1963. The average interval was 27 minutes. The extreme variations were 25 and 28 minutes.

Bench Geyser: A crack in the geyserite at the time of the 1959 earthquake resulted in the development of a fumarole at the present site of Bench. In May, 1961, a small crater was excavated by the steam and Bench began to have eruptive periods. This spring made a direct transition from fumarole to geyser. The height of the eruptions varied between 2 and 3 feet; the interval varied from 1 to 3 minutes. Beginning in 1963 the eruptions became more powerful, varying from 5 to 7 feet. There was further increase in 1964. Some of the eruptions were 8 to 10 feet high. The duration of the eruptions is about half a minute. Occasionally Bench will have dormant periods lasting for several days. It is located about 150 feet north of Plume.

Beehive Geyser: For the first few months following the 1959 earthquake, Beehive with many geysers shared in an increase in eruptive activity. Following 1960 there was a steady decrease in number of eruptions through 1961, 1962 and 1963. However, 1964 saw a marked increase in its eruptive frequency. From May 1 to October 30, 22 eruptions are known to have occurred. This compares with 9 for 1961, 5 for 1962 and 3 for 1963.

While 1964 showed a total loss of 106 degrees for all springs in Geyser Hill, Beehive proved to be an exception. Its 1964 temperature was 4 degrees above that for 1963 (see chart). There is little doubt but that

Following the earthquake of August 17, 1959, there was an abrupt rise in temperature of the great majority of hot springs in the Firehole Geyser Basins. A few springs declined in temperature, among which were a few important geysers. However, on the whole there was a significant increase. Temperatures of all springs for which there were comparative data showed that the average rise, due to the earthquake, amounted to 5.6°F. This significant increase in thermal energy was most in evidence in quiescent springs, springs much below the boiling temperature. Many of these non-boiling springs became eruptive at the time of the earthquake. Periodic eruptive activity persisted in some for periods ranging from days to months. Some are still active. For the remainder of 1959 and most of 1960, there was a marked increase in geyser activity. This was particularly true of minor geysers.

Temperature data for September, 1960, showed that the overall temperature increase due to the earthquake was still persisting. However, since then September readings have indicated that the overall temperature was slowly declining. The most marked drop occurred between September, 1963, and 1964. The loss in temperature for all springs between these dates amounted to 359 degrees. This represents an average drop of 1.67°F. per spring.

With reference to the earthquake-stimulated hot spring activity the author has written:

The fact that springs of quiescence and relatively low temperature before the earthquake showed greatly increased temperature and continued eruptive activity is positive evidence of a sudden increase in thermal energy arising from some source. This could have been brought about in a number of ways. Gases and fluids, issuing from fissures or a fault connected to the source of magmatic energy, might be given a sudden impetus of movement by fresh fracturing, thus making more ready ascension possible. It would also be probable that steam, resident in surficial structure, but normally impeded in egress by overlying rocks and clay, was suddenly made available. That such a heat potential exists is based on borings which have been made in many tracts of hot ground, particularly those in California and Italy. Should this be the principal source of present post-quake increase in thermal energy, it would not be inconceivable that the overall temperature in the geyser basins might, as a result of heat dissipation, decline below pre-quake conditions.*

The general loss in temperature of the hot springs since its marked increase in 1959 is suggestive that the increase in thermal energy due to the earthquake did not result from deep-seated fracturing, resulting in increased magmatic effusions. Had this been the situation it seems

* Billings Geological Society, Eleventh Annual Field Conference, pp. 62-63.

On the other hand, White Geyser gained 2 degrees over 1963. This was enough to result in an eruptive cycle.

Three Sisters: These springs have never recovered from the 1959 jarrings. Water is still down from 12 to 18 inches in all craters. Two geysers are located in the north crater. Both were active during 1964. However, the one on the east side of the crater erupted less frequently than in 1963.

Little Brother: This is the most active geyser in the Myriad Group. For several years it has been erupting about every 15 to 20 minutes; the eruptions lasting for about 4 minutes and jetting water to a height of about 18 feet. About the middle of June it changed its pattern of activity. The eruptions occurred every 10 to 12 minutes; the duration from a minute to a minute and a half. The new activity persisted for the rest of the season.

Black Sand Basin

The loss of 31 degrees in this basin was most pronounced in Rainbow and Handkerchief Pools. In both springs the algae was of darker hue than in 1963. The level of Rainbow was about a foot below overflow. The lower temperatures in the basin resulted in lessened geyser activity. But one eruption of Cliff--October 21--was observed and none of Green Spring or Sunset Lake. The small geyser across the creek from Cliff, and near the parking area, did not erupt. Whistle Geyser was hotter than in 1963, but there was not sufficient increase in temperature to bring about an eruption. The color of Emerald Pool was the same in 1963. This was due to no fluctuations in temperature. There was no apparent change in activity of Spouter Geyser.

Daisy Group

This important group of springs is one of very few in the Firehole Basins which did not show a loss in temperature. The greatest gain in temperature was in Murky Spring which gained 22 degrees. The temperatures of the boiling springs were essentially the same as in 1963. Daisy and Daisy's Thief were one degree hotter than the previous season.

The great sensitivity to changes in temperature and hydrostatic pressure of geysers in this group is indicated by changes in pattern of activity when there is alteration in the above factors.

All of the important springs in this group are connected subterraneously. Water level in all is essentially the same. Over the years there has been periodic shifting of the thermal energy from one spring to another. Whether or not increased energy was directed to or away from a particular spring would determine whether or not it was in an active or dormant cycle.

Prior to the effects of the 1959 earthquake Daisy was by far the most active of the big geysers in this group. Except for brief periods when energy necessary to make Daisy play would shift to Brilliant or Bonita Pools or Splendid Geyser, Daisy would erupt with marked frequency and regularity.

The 1959 earthquake resulted in pronounced changes in this group. The focus for the release of maximum thermal energy shifted from the springs in the middle and west side of the group to the east side. For a few months this resulted in greatly increased activity of Daisy. However, further shift to the east brought about dormancy of Daisy. This dormancy was caused by heavy overflow of Bonita Pool. Since 1960 this overflow (about 60 gallons per minute) has not only persisted, but was greater in 1963 and 1964 than it was the two previous years.

Present heavy overflow of Bonita, while primarily due to the earthquake, has been augmented by deflation of the sinter on the side of the discharge. This deflation has come about by using the area for a road; also a parking lot.

It was earlier mentioned that the springs in the Daisy Group are very sensitive to changes in hydrostatic pressure and temperature. On numerous occasions prior to the 1959 earthquake, a slight rise in water level of Bonita and Brilliant Pools or Splendid Geyser, with resulting overflow, rendered Daisy dormant until overflow ceased and energy shifted back to Daisy.

In the late part of the 1964 summer a check was put in Bonita's overflow channel, resulting in the level of the water rising about 4 inches. With the rise in Bonita there was a corresponding rise of water level in Brilliant Pool, Daisy, Comet and Splendid Geysers and Daisy's Thief. This rise resulted in a sufficient shift of energy away from Bonita to bring about an eruption of Daisy's Thief. An eruption of the Thief is a precursor to an eruption of Daisy. From 30 to 45 minutes following the start of the Thief's eruption Daisy will erupt. As long as the Thief continues to erupt Daisy will play about every hour. During this period the crater of Brilliant Pool is empty. When the Thief ceases to erupt the energy shifts back to Bonita resulting in its overflow.

During two days when Daisy's Thief was intermittently active, Daisy erupted several times. Following a clumsy removal of the check in Bonita, permitting water to drop to its prior level, water simultaneously dropped in all other springs. There was no further action of Daisy or Daisy's Thief.

The above situation is indicative of the delicate balance which exists between many springs connected subterraneously. Even small changes in hydrostatic pressure, which come about naturally or can be manipulated, affect dormancy or activity of many geysers.

A very different relationship seems to exist between Daisy and Daisy's Thief than was the case before the 1959 earthquake. Before the quake any activity of the Thief prevented an eruption of Daisy--hence the name Thief. Since the quake, activity of the Thief has had an opposite effect, being a certain forerunner of one or more eruptions of Daisy. In the scientific interest of determining present interfunctional relationships in the Daisy Group it is highly desirable that for a period all flow from Bonita Pool be checked. In doing this the investigator would be working with and not against nature.

Round Spring Group

North Round Spring and Round Spring Geyser were the only units in this group which showed an increase in temperature over 1963. The temperature was down in all other springs.

During most of the season, Round Spring erupted constantly, the temperature increase no doubt being responsible for near steady activity. It discharges about 3 gallons per minute. Pear Geyser had intermittent and infrequent eruptions. During 1963 Round Spring overflowed constantly. During 1964 there was no overflow. Periodically the bowl would fill to near the top and then the water would drop from 10 to 12 inches. Being situated by a parking area, Round Spring is the recipient of a considerable amount of trash.

Orange Spring Group

The two small geysers 200 feet east of Orange Spring were active several times each day. Both erupt to a height of about 6 feet, the eruptions lasting from 8 to 10 minutes. The water in Orange Spring stood near the top of the crater. At times there would be slight overflow. An unnamed spring 30 feet southwest of Orange would occasionally have short periods of heavy overflow. A spring 200 yards southeast of Orange overflowed constantly, discharging about 10 gallons per minute.

Castle Group

Castle Geyser: Castle erupted with marked regularity all season. Most of the time its eruptions were predictable within a half hour's range. The maximum interval checked was 10 hours and 30 minutes; the minimum, 7 hours and 40 minutes. Both of these intervals occurred during July. The average interval for the season was 9 hours and 7 minutes. The 1964 average was 29 minutes less than the 1963 one.

Pre-eruption surging of Castle begins from 90 to 120 minutes before an eruption. Splashing mixed with spray characterize its post-eruption behavior for 3 to 4 hours. There are only about 3 hours from one

eruption to the next when no water, in the form of splashes or spray, is being jetted above the rim of the crater. Spray mingled with splashing is a post-eruption symptom. Surging minus the spray precedes an eruption.

Crested Pool overflowed steadily all season. The degree of overflow fluctuated, being heaviest during a 4 to 5 hour period preceding an eruption of Castle. It has apparently completely recovered from the effects of the 1959 earthquake.

Grand and Sawmill Groups

Significant changes were observed in a few of the springs in these groups. There was waning activity in some and increased activity in others. Lower temperatures in Scalloped Springs resulted in no eruptive activity of North Scalloped and no overflow of South Scalloped. Since 1959 there had been steady overflow of the latter spring. Overflow of Churn was less frequent than during 1963.

Liberty Pool persists in its earthquake-changed pattern. Periodically the water wells up and overflows. It is still about 40 degrees hotter than before the earthquake. The same is true of nearby Frog Pool, so named because prior to the 1959 earthquake the water was cool enough to support plant and frog life. At times water boils in both of these springs. East Frog overflowed steadily all season.

Sawmill Geyser: During 1964 Sawmill erupted on essentially the same pattern and frequency as it did prior to 1963. The infrequent activity during 1963 seemed to result from increased activity of nearby Penta Geyser and near constant activity of Tardy Geyser. The small unnamed geyser on the south rim of Sawmill's crater was seen in frequent eruptive activity during the latter part of the season. The vent is only about 2 inches in diameter; the height of the eruption 7 to 9 feet, lasting for about 2 minutes.

Bulger Geyser: An eruption of Bulger lasts from 6 to 8 minutes and recurs about every 4 hours. The water boils constantly in the crater, becoming more agitated prior to an eruption. The height of the eruption is 6 to 8 feet. It and nearby Belgian Pool were subjected to a considerable amount of vandalism during 1964.

Grand Geyser: During 1964 Grand for the first time since the 1959 earthquake began erupting with some degree of regularity. The great majority of the intervals varied between about 15 and 30 hours; 24 hours being average. Two intervals, each of 8 1/2 hours, occurred during the season. The greatest amount of activity occurred during July and August, when 40 and 44 eruptions respectively were recorded.

The steady increase in frequency of Grand's eruptions since its earthquake-induced dormancy is indicated by the following comparisons:

1960, 28 eruptions; 1961, 47 eruptions; 1962, 98 eruptions; 1963, 125 eruptions; 1964, 182 eruptions. The above data were collected between May 1 and November 1.

The interfunctional relationship which exists between Grand, Turban and Vent has shown variation over the years. Prior to the 1959 quake Vent always began erupting near the conclusion of the first or second burst of Grand. It was never known to erupt independently of Grand. Its eruptions were always induced by an eruption of Grand. Since the earthquake, Vent has occasionally acted as a precursor to Grand, its eruption starting from one to two hours ahead of Grand's. In June a new type of relationship was noted when Vent was observed to precede Grand by about one minute. At times they began erupting simultaneously. However, most of the season Vent would start during the first or second burst of Grand, which can be considered its usual or normal pattern.

The location of Grand, Turban and Vent at the base of a talus slope subjects them to an inordinate amount of vandalism. Following an active phase of Grand its crater as well as Turban's is empty. During this period in 1964, on a number of occasions, I removed rocks from their craters. Some of the rocks that have been thrown into Turban's crater over the years are presently sealed in a geyserite matrix. The same, no doubt, is true of Grand's, but the depth of its vent precluded observation. The crater of a small spring 200 feet north of Grand was completely filled with rubble during 1964.

Economic and East Economic Geysers showed no signs of activity during the season. Their craters were lined with algae indicating low temperatures. Water continues to flow from Chromatic with the water in Beauty standing slightly below overflow. The springs in the vicinity of Witches Cauldron were in essentially the same state as during 1963.

Giant Group

Most of the springs in this group have undergone but minor alterations since Giant entered its present dormant cycle in October, 1955. Following the earthquake, activity of Catfish and Turtle ceased with but feeble activity of Mastiff. The earthquake resulted in an increased shift of the thermal energy to the Grotto Group.

During 1964, water frequently splashed above the rim of the broken side of Giant's crater, but no heavy surging, such as characterizes it when it is in an active cycle, occurred. During most of the season, water flowed from South Purple Pool. This flow resulted from discharge of a spring in the edge of the timber whose water flowed into South Purple Pool.

Oblong Geyser: With the advance of the season Oblong's eruptions recurred with increased frequency. From April to mid-July the intervals varied from about 6 to 8 hours while during the latter part of the season most of the eruptions varied between 4 and 5 hours. The maximum interval checked was 8 hours and 42 minutes, the minimum, 3 hours and 50 minutes.

Grotto Group

The activity in this group was of essentially the same character as in 1963. Grotto was in an active phase fully half of the time. The quiet as well as the active phases varied from about 45 minutes to about 10 hours. When the intervals are short, an eruption of Grotto is not preceded by eruptive activity of Grotto Fountain. No major eruption of Spa was observed.

None of the springs which form the Chain Lakes overflowed or boiled during the season. The craters of most of these springs were lined with algae, indicating low temperatures. The two springs on the north end of the chain possess potential for major eruptions. The same is true of nearby Link Geyser. Only minor eruptions of Link occurred during 1964.

Riverside Geyser: Like Castle, Riverside's average interval was shorter in 1964 than in 1963. The average in 1963 was 7 hours and 6 minutes, while the 1964 average was 6 hours and 20 minutes. The minimum interval was 5 hours and 30 minutes, the maximum interval 7 hours and 2 minutes. Intervals under 6 hours had not occurred on Riverside since the first few months following the 1959 earthquake. Between May 1 and November 1 Riverside erupted 579 times.

The small vent next to the hill on the Riverside platform started erupting at a longer period preceding Riverside than I have observed any previous season. The starting of the vent ahead of Riverside is quite variable. On rare occasions they will start simultaneously. However, it is more common for the small vent to start from about 30 to 45 minutes before Riverside. During 1964, the vent's action preceded Riverside's by 58 to 78 minutes.

Spiteful Geyser: This geyser was named by Arnold Hague. No description can be found of its early activity. It is situated on the geyserite embankment 25 feet north of Fan. During the 1950 cleanup, over a pickup load of rocks, cans and bottles were removed from its crater. The bottom of the crater is still covered with tourist introduced rubble.

On a number of occasions in July, Spiteful was observed in an eruptive state. This was the first I had ever observed a natural eruption of this spring. The beginning of no eruption was noted, hence the duration was not determined. It is a splash-type eruption, the higher jets reaching about 10 feet. But one known eruption of Fan and Mortar occurred.

Morning Glory Pool: The water level in Morning Glory was at the top of the bowl all season with no overflow. There was slight seepage which disappeared in the formation a few feet from the pool. Morning Glory's temperature since the 1959 earthquake continues to go slowly down. The 1964 September reading was 157 (the lowest ever recorded) whereas the 1963 reading was 162 degrees. During 1964 this pool was the recipient of its usual seasonal quota of coins and trash.

Cascade Group

The intervals on Artemisia varied between about 20 and 30 hours. As far as can be determined its eruptions do not affect nearby springs. Atomizer was seen in an eruption on several occasions.

Sometime during the winter of 1963-1964 Gem Pool began having periods of overflow. This is the first it had overflowed since October 1959. From then until the winter period above referred to, the water stood about 8 inches below overflow.

Past observations had indicated that subterranean connections existed between Gem and Calthos. The behavior of these two springs during 1964 added additional evidence of a sympathetic relationship. An exchange of function, or a shift of the thermal energy, between these springs took place with remarkable frequency, occurring about every 24 to 72 hours. In the case of all other springs observed, the exchange of function does not take place short of a few weeks or months, and in some cases, years. In the case of Gem and Calthos, first one pool would overflow and then the other. During the non-active periods the water would drop about 6 to 8 inches in the respective craters. The overflow was usually heavier from Gem than Calthos. Sometimes the bowl of Calthos would fill without overflow, suggesting another possible underground connection between these two springs.

The water is down about 20 inches in Pulcher Spring. This spring is situated at the northwest base of the large mound of Calthos. It is oblong in shape and consists of two separate vents. Sometimes the water stands high enough so that both vents form a single pool. There was no major activity of Hillside Geyser, only steady boiling.

Seismic Geyser: Seismic is one of Yellowstone's newest geysers. It is a product of the 1959 earthquake. Prior to the earthquake the site where it is located was a tree-covered bench of geyserite, forming an embankment of the Firehole River. It is about 200 feet west of the Calthos mound.

The 1959 earthquake resulted in the formation of a rift in the geyserite at the point above indicated. This resulted in the genesis of a very hot fumarole which killed the trees over an area of several square yards. The new fumarole showed little change in size and forcefulness

until 1963. When visiting the site in the spring of that year I observed that sometime during the previous winter an explosion had taken place and that where steam had been hissing through a rift, there now was a large crater. Blocks of sinter strewn about the crater indicated it had formed explosively.

During all of 1963, water jets about 3 feet in height played into the crater every few seconds. No water stood in the crater. It drained away immediately following the jetting. During 1964, the jetting became less frequent but more forceful. Some of the jets shot out at angles to a height of about 12 feet. There has been a slow rise of water in the crater. It is now about 4 feet below the rim. This new geyser is still in the early stages of evolution. It will be interesting to follow its development.

Biscuit Basin

The springs on the east side of the river were in essentially the same state as during 1963. The two new springs near the parking area which resulted from the 1959 earthquake continue to function despite the fact an attempt was made to smother them by dumping a truck load of sand on them. The two small geysers near Cauliflower which began functioning following the earthquake continue to erupt on short intervals. One is located in one of the early roads leading into the basin.

Sapphire Pool: The activity of Sapphire is apparently becoming somewhat stabilized following its 1959 blitzkrieg. During the past two seasons there has been no observable change in the height or frequency of the eruptions. The eruptions occur about every 15 minutes, most of them being about 20 feet in height. The absence of major eruptions is apparently due to a loss in thermal energy and not to underground alterations in plumbing, and this despite the great destruction to the structure which occurred immediately in and about the crater. The water still lacks the crystal clearness which characterized it prior to the earthquake. Presently it is of a turquoise hue.

With the exception of Jewel Geyser, the springs west of Sapphire showed little change from their 1963 state. There was some waning of activity in the latter part of the season. Water is still down from 4 to 5 feet in the craters of Mustard Springs. Both are in a constant state of ebullition. West Mustard shows some geyser characteristics. North Geyser overflowed steadily but was dormant. The southwest vent of Avoca is still down about 20 inches. There is steady boiling in the north vent, which becomes more violent every 60 to 80 seconds, jetting the water up about 10 feet.

Jewel Geyser: Over the years Jewel has shown great regularity, erupting about every 5 to 8 minutes. During an eruption there usually has been 3 separate bursts of water, the highest being from 12 to 15 feet. In the early part of August the eruptions became greatly enfeebled.

The activity recurred with about the same frequency, but some of the eruptions consisted of little more than a welling out of the water. At times there would be but enervated boiling; other times no more than a single jet which would vary in height from about 6 to 15 feet. Like Sapphire, its water is still discolored from the effects of the 1959 earthquake.

Midway Geyser Basin

Conditions in this basin seem to be fairly stable. One of the interesting changes since 1963 was the refilling of the crater of Turquoise Pool and restoration to its former loveliness. The only pool in this basin not refilled since a drop in level due to the earthquake is the large one near Flood Geyser. It is still about 6 inches below overflow.

The River Spouter, a steady geyser which turned into a steam vent in 1962, shows no further alteration in behavior, except for a short period during high water when its vent is flooded. The new geyser 200 feet to the east continues to erupt. Excelsior, Opal, Indigo, Flood, Tromp and Catfish showed no alterations in functional behavior over those of 1963.

Lower Geyser Basin

Great Fountain Geyser: During the season 41 eruption intervals were determined. The minimum interval was 6 hours and 2 minutes, the maximum, 10 hours and 18 minutes, while the average was 7 hours and 45 minutes. Its behavior pattern was very similar to that of 1963. Few eruptions were in excess of 100 feet in height.

No long overflow periods of Great Fountain occurred during the season. However, an observation on October 27 revealed that the water level was down about 9 feet below the rim of the crater. The state of the water on the terraces indicated it had been 20 hours or more since there had been an eruption. There was no boiling in the crater, however, where the water touched the sides of the bowl there was slight sizzling indicating a superheated state.

The water remained at low ebb through all of the 27th and 28th. It erupted sometime during the night of the 28th. On but one previous occasion, November 8, 1962, has Great Fountain been known to behave in the manner above described. The low ebb, as well as the long periods of overflow without an eruption, are apparently the result of a cooler body of ground water which becomes available about this time of the year. It is no doubt a heavy influx of cooler water that resulted in the abnormally low ebb and slow response of Great Fountain in overcoming the effects of an eruption.*

* See Seasonal Changes in Ground Water in Relation to Hot Spring Activity. American Journal of Science, Vol. 262, May 1964, pp. 674-685.

The behavior pattern of Surprise Pool showed no variation from 1963. It would overflow about hourly, following which the water would ebb from 4 to 6 inches. Firehole Pool, originally named Beauty Pool, has shown no variation during the period I have observed the hot springs. It came through the 1959 earthquake without showing any effects. Being next to a parking area it is the recipient of much trash. The water is down about 15 inches in Broken Egg Spring and it stays murky.

White Dome Geyser: The majority of the intervals varied between about 15 minutes and a half an hour. Occasionally there were days when the intervals would be from 45 minutes to over an hour. Frequently the small geysers situated both east and west of White Dome were observed erupting. The two small geysers 100 feet east of White Dome which erupt simultaneously are named Gemini.

Pink Cone Geyser: An eruption of Pink Cone occurs about every 6 hours. The eruption lasts for about an hour and 45 minutes. The heavy part of the discharge is during the first 10 to 15 minutes of the eruption. At times steam mingles with spray is the major part of the discharge, then after a few seconds pause water will again become dominant. Nearby Bead Geyser played with marked regularity, the intervals varying between 27 and 30 minutes. Shelf Spring overflowed steadily all season, discharging about 3 gallons per minute. Four unnamed geysers near Bead were periodically active all season.

Firehole Lake: The flow from all springs seemed to be constant and unvarying. A small geyser, the one possibly named Young Hopeful by the Hayden Survey, erupted steadily all season.

Fountain Group

No periods of ebb and flow were observed in Silex. The flow was steady all season. Silex was not the recipient of as many coins as during the past few seasons, but a number of rocks which had been placed as a wall next to the old road were thrown into the crater. The new alignment of the walk past Celestine Pool should reduce vandalism here.

Fountain Paint Pot: Four new craters have formed on the west side of the Paint Pot beneath where the old flagstone walk lay. There was little or no alteration in 1964 in individual mud springs in the main crater. However, there is steady enlargement in the mud springs which formed following the 1959 earthquake, and which lie to the north outside the main crater. The one nearest the Paint Pot was especially active in 1964.

Red Spouter: This new mud spring serves as an indicator as to the height of the water table in the Fountain Group. It ejects muddy, reddish-colored water for about 7 months and is a steam vent for the remaining 5 months of the year.

In the third week of May, 1964 Red Spouter changed from a liquid to a gas phase. However, due to heavy rains it shifted back to the liquid phase about June 12, which condition lasted until July 1, when it again became a steam vent. Since this spring came into being following the 1959 earthquake this is the first time a shift in type of activity has occurred that was due to increased precipitation. With the June change from a gas to a liquid phase there was also a rise in level of the Fountain Paint Pot. Red Spouter returned to the liquid phase on October 21.

During the season, water in Leather Pool ebbed to the lowest point it has been since the drop following the earthquake. Its temperature was hotter than during previous seasons, this no doubt being due to lessened hydrostatic pressure.

Fountain Geyser: Following Fountain's rejuvenation in 1963, it began erupting on about 12 minute intervals. The eruptions would last for 4 minutes, with a height varying between about 10 and 15 feet. As the season progressed the intervals became more irregular and longer; also the force of the eruptions became greater. This irregularity was evident at the beginning of the 1964 season. As the season progressed it was observed that Fountain was not only erupting with great frequency, but that there were two types of eruptions--minor and major ones. Minor eruptions occurred about every 12 to 18 minutes and lasted for about 4 minutes. Some of the major eruptions lasted for over 2 hours, with occasional bursts 30 to 40 feet high. The vigor of these eruptions was very similar to the pre-quake type.

During the early part of the season there were occasional eruptions of Jet Geyser, but during the latter part of the season it was dormant. Spasm Geyser was much more active during the early part of the season than from early July on.

Clepsydra Geyser: For 3 1/2 years following the 1959 earthquake, Clepsydra erupted steadily. The rejuvenation of Fountain in 1963 resulted in occasional pauses of Clepsydra. During 1964, these pauses became longer with the increased activity of Fountain. During 1964, Clepsydra's steam vent was much more active than in 1963.

Kaleidoscope and Pithole Groups

Twelve unnamed springs in these groups showed geyser activity during the season. In most of them the eruptions occurred frequently and were minor in character. Of the larger geysers, Kaleidoscope was the most regular, the eruptions occurring every 5 to 8 minutes. There was a considerable amount of geyser activity in the large springs near Kaleidoscope, particularly Deep Blue and Honeycomb. Gentian has been very stable since its recovery in 1960. It discharges about 30 gallons per minute. It is one of the loveliest springs in the Park.

Pocket Basin

Sometime during late 1963, new hot ground developed on the side of a large moraine located on the southeast side of Pocket Basin. In 1964, this condition was in evidence by a new kill of Lodgepoles in the same area where numerous trees were killed following the 1959 earthquake. The 1963 kill apparently resulted from further opening of a deep seated fissure underlying the moraine.

The numerous moraines in the Pocket Basin area, and their relation to present mud and turbid springs, presents significant evidence that this area marks the site of pre-glacial hot springs. This early hot-spring group was in direct line with the movement of the Lamar Glacier, by which it was buried. The ice thrust over the hot ground resulted in deposits unique in the geyser basins, which I have designated as thermal moraines.

The extensive development of new mud springs in the Pocket Basin following the 1959 earthquake is indicative that glacially-buried hot springs are slowly finding egress through the gravels. It is not unlikely that hot springs in this area will be more numerous and vigorous in the future than at present.

Old Faithful				
Month	Intervals Checked	Minimum Interval in minutes	Maximum Interval in minutes	Average
May	237	38	90	66.97
June	284	43	85	66.9
July	438	38	92	67.3
August	374	31	96	67.6
September	272	44	92	66.56
October	201	41	86	67.1
Total	1806	31	96	67.07

26

1967

Hot Spring Activity In The Geyser Basins Of The
Firehole River For The 1967 Season

George D. Marler

Geyser activity was known to occur in the following hot springs during 1967

LOWER BASIN

Great Fountain Group

- | | | |
|--------------------------|----------------------|------------------|
| 1. Great Fountain Geyser | 2. White Dome Geyser | 3. Gemini Geyser |
|--------------------------|----------------------|------------------|

Pink Cone Group

- | | | |
|---------------------|---------------------|---------------|
| 1. Pink Cone Geyser | 3. Narcissus Geyser | 4. Box Spring |
| 2. Bead Geyser | | |

Firehole Lake

- | | |
|------------------|-------------------------|
| 1. Steady Geyser | 2. Young Hopeful Geyser |
|------------------|-------------------------|

Fountain Group

- | | | |
|---------------------|----------------|----------------|
| 1. Clepsydra Geyser | 3. Sub Geyser | 5. Mask Geyser |
| 2. Jelly Geyser | 4. Red Spouter | 6. Twig Geyser |
| | | 7. Jet Geyser |

Hotel Group

- | |
|------------------|
| 1. Kidney Geyser |
|------------------|

Kaleidoscope Group

- | | | |
|------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
|------------------------|---------------------|---------------------|

Morning Mist Group

- | | |
|------------------------|--------------|
| 1. Morning Mist Geyser | 2. The Snort |
|------------------------|--------------|

Twin Buttes

- | | |
|--------------------|-----------------|
| 1. Imperial Geyser | 2. Spray Geyser |
|--------------------|-----------------|

MIDWAY BASIN

- | | | |
|-------------------|----------------------|----------------------|
| 1. Catfish Geyser | 3. East Flood Geyser | 4. West Flood Geyser |
| 2. Tromp Spring | 4. Mud Spring | |

UPPER BASIN

Biscuit Basin

- | | | |
|-----------------------|-----------------------|------------------------|
| 1. Cauliflower Geyser | 4. Shell Geyser | 7. West Mustard Spring |
| 2. Sapphire Pool | 5. Avoca Spring | 8. Island Geyser |
| 3. Jewel Geyser | 6. Black Pearl Geyser | |

Cascade Group

- | | | |
|---------------------|-------------------|--------------------|
| 1. Artemisia Geyser | 2. Seismic Geyser | 3. Atomizer Geyser |
|---------------------|-------------------|--------------------|

Morning Glory Group

- | | | |
|-------------------------|--------------------|-------------------------|
| 1. East Sentinel Geyser | 2. Spiteful Geyser | 3. West Sentinel Geyser |
|-------------------------|--------------------|-------------------------|

Grotto Group

- | | | |
|------------------|--------------------------|---------------------|
| 1. Grotto Geyser | 4. Surprise Geyser | 7. Riverside Geyser |
| 2. Rocket Geyser | 5. South Surprise Geyser | |
| 3. Spa Geyser | 6. Link Geyser | |

Giant Group

- | | |
|-----------------|------------------|
| 1. Bijou Geyser | 2. Oblong Geyser |
|-----------------|------------------|

Grand Group

- | | | |
|------------------|----------------|------------------------|
| 1. Grand Geyser | 3. Vent Geyser | 5. West Triplet Geyser |
| 2. Turban Geyser | 4. Rift Geyser | |

Castle and Sawmill Groups

- | | | |
|-------------------|---------------------|-------------------|
| 1. Castle Geyser | 5. Spasmodic Geyser | 9. Spanker Geyser |
| 2. Tilt Geyser | 6. Tardy Geyser | 10. Oval Spring |
| 3. Sawmill Geyser | 7. Bulger Geyser | 11. Deleted Tardy |
| 4. Penta Geyser | 8. Sprinkler Geyser | |

Black Sand Basin

- | | | |
|-------------------|-----------------|----------------|
| 1. Spouter Geyser | 2. Cliff Geyser | 3. Sunset Lake |
|-------------------|-----------------|----------------|

Daisy Group

- | | | |
|-----------------|----------------|-------------------------|
| 1. Comet Geyser | 2. Bank Geyser | 3. White Pyramid Throne |
|-----------------|----------------|-------------------------|

Myriad Group

Three Sisters:

- | | | |
|-----------------|-------------------|-----------------|
| 1. North Crater | 3. Little Brother | 5. White Geyser |
| 2. East Crater | 4. Round Geyser | |

Giantess Group

- | | | |
|-------------------------|------------------------|---------------------|
| 1. Little Squirt Geyser | 7. Lion Geyser | 13. Vault Geyser |
| 2. Anemone Geyser | 8. Goggle Spring | 14. Giantess Geyser |
| 3. Surge Geyser | 9. North Goggle Spring | 15. Infant Geyser |
| 4. Plume Geyser | 10. Beach Spring | 16. Solitary Geyser |
| 5. Beehive Geyser | 11. Aurum Geyser | 17. Bench Geyser |
| 6. Depression Geyser | 12. Sponge Geyser | 18. Cone Geyser |

Old Faithful Group

1. Old Faithful

Lone Star Group

1. Lone Star

Great Fountain Group

Since 1960, when most of the springs in this group had become somewhat stabilized in their activity following the 1959 earthquake, most of the geysers have shown little variation in their eruptive patterns.

White Dome: During the season 24 minutes was the shortest interval determined on this geyser. The maximum interval was in excess of an hour. The cause of White Dome's frequent change in length of intervals has not been determined. There are periods when the great majority of the eruptions come near minimum time. There are other periods when the intervals are from 45 to 90 minutes.

Gemini Geyser, which is situated across the road from White Dome, was frequently observed in an active state. This geyser, and other springs near it, are subject to considerable vandalism.

Surprise Pool continues to ebb and flow as it did in 1961. At about 1 hour intervals it will overflow for a few minutes then ebb about 6 inches. This kind of behavior never characterized it before the 1959 earthquake.

Great Fountain: Except for a short period in August Great Fountain followed a somewhat set pattern of activity all season. The intervals varied between about 6½ and 9 hours. A digression from this pattern of activity occurred on August 21 when the geyser began erupting about every 5 to 7 minutes, the water phase lasting about 5 minutes. This type of function lasted for not less than 36 hours, followed by a drop in water level of not less than 9 feet. Water stayed at this low level for the greater portion of a day. The crater then began to slowly fill. By the 26th Great Fountain was again erupting in a normal manner, and has continued so to date (through October).

Table of Great Fountain's Activity for the 1967 Season

	<u>No. of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
<u>May</u>	9	7 hr, 50 min.	8 hr, 31 min.	7 hr, 30 min.
<u>June</u>	21	7 " 35 "	8 " 19 "	7 " 06 "
<u>July</u>	38	7 " 47 "	10 " 17 "	6 " 12 "
<u>August</u>	29	7 " 46 "	8 " 55 "	6 " 31 "
<u>September</u>	22	8 " 13 "	9 " 11 "	6 " 23 "
<u>October</u>	18	8 " 11 "	11 " 40 "	7 " 04 "

Pink Cone Group

Pink Cone Geyser: Since about 1962 there has been little variation in Pink Cone's eruptive activity. It has settled down to about six hour intervals with the eruptions lasting near two hours. The heavy part of the discharge is during the early part of the eruption. Pink Cone has a habit of just about ceasing all activity then it will start with renewed vigor. It is a cone-type geyser.

Bead Geyser, which is near Pink Cone, erupted with marked regularity, the intervals varying between 27 and 30 minutes. Box Spring and two other unnamed small geysers near Bead were frequently active. Narcissus was also observed erupting.

Firehole Lake: There was little observed variation in the flow of the springs in the Firehole Lake area. Steady Geyser, as well as Young Hopeful and an earthquake-caused geyser were constant in their activity. On October 11 the top vent on the cone of Steady began erupting. The 1959 earthquake rendered it dormant. In late October two small vents near Young Hopeful began erupting.

Fountain Group

No ebbing was observed in either Celestine or Silex Springs. Some seasons there is frequent ebb in Silex.

Fountain Paint Pot: During the past three seasons there has been little change in the mud puffs in this famous spring. Resulting from the 1959 earthquake there is still increased activity in the north end of the crater.

Red Spouter: This new mud spring is in the process of enlarging its crater. Following the earthquake but one vent developed. Since 1965 three vents have developed, all of which show about the same characteristics. Red Spouter changed from liquid to steam phase in late May of this season. By October 10 one of the vents was again ejecting mud. It is usually near the end of October before all steam action ceases.

Clepsydra Geyser: No pauses were observed in the steady activity of this geyser. This no doubt was responsible for the dormancy of Fountain, Morning, Spasm and a few other small geysers in this group.

Hotel Group

This group consists of several named springs. Most of the springs are small and of little or no discharge. They were named by the Hayden Survey which had its camp nearby while working in the Lower Basin. During 1967 Kidney Spring was the only one observed to show any geyser activity.

Kaleidoscope Group

Most of the numerous springs in this group possess geyser potential, as was evidenced by the 1959 earthquake. As a result of the quake several new geysers developed. With the exception of Earthquake Geyser most of them were small - 6 to 10 feet. The small ones are still erupting.

Kaleidoscope is the most famous geyser in the group. The past season it was active about every 6 to 10 minutes. Some seasons it is dormant due to a shift of the thermal energy to a nearby geyser.

Deep Blue and Honeycomb Geysers are located within a hundred feet of Kaleidoscope. Both showed frequent eruptive activity during the season.

River Group

The most notable change in this group was the change in function of Ojo Caliente (Hot Eye). It is highly suggestive that as a result of nearby drilling additional steam was diverted to this spring and it began behaving as a geyser. In the initial stages of the eruption turbid water jetted up 6 to 8 feet. The water soon cleared. The heavy boiling, characteristic of an eruption, then recurred about every 2 minutes. By October this kind of activity was continuing on slightly longer intervals. Boiling is continuous, but about every 2 to 10 minutes water will surge up about 2 feet, with some splashes going about 3 feet.

Twin Buttes

Imperial Geyser after 37 years of dormancy began erupting in August 1966. Since its rejuvenation it apparently has been a steady geyser. Observations made the past season indicate continuous activity. On cold or humid days, steam from the eruption can be seen on the south side of South Twin Butte from points in the Lower Basin. This is unusual activity for a geyser of this type.

MIDWAY BASIN

This basin was characterized by very stable activity. The overflow from Excelsior, Grand Prismatic and Indigo seemed unvarying in volume.

East Flood Geyser erupted several times each day, while West Flood erupted much less frequently. I have never observed these two geysers, which are on opposite banks of the Firehole River, erupting in concert.

The large, unnamed spring near East Flood has not yet filled following its big drop due to the 1959 earthquake. Other geysers observed erupting in this basin are Tromp, Catfish, Mud Spring and River Geyser. There is an unnamed, earthquake-caused geyser near River Geyser.

UPPER BASIN

Biscuit Basin

Over the years Sapphire Pool has been the most famous spring in this basin. The profound changes it underwent as a result of the 1959 earthquake have resulted in a less beautiful spring. Most of the biscuits which formerly surrounded the pool were torn away by violent eruptive activity. It does not have the brilliant sapphire color it did before the earthquake.

Sapphire this season is erupting less frequently than at any time in its known history except during the major eruptive period following the earthquake. Eruptions in 1967 recurred about every 30 minutes, and were from 4 to 12 feet in height.

Other geysers observed erupting during the season in this group include Cauliflower, Shell, Jewel, Avoca, West Mustard, Black Pearl and Island. Activity was also observed in four small unnamed geysers on the east side of the river.

Island Geyser is located on a small island in the Firehole River at the point where the runoff from Sapphire enters the river. It began erupting in May 1966 and so far as can be determined has erupted steadily since that time. It is a product of the 1959 earthquake. In addition to the main vent which jets a large volume of water 5 to 6 feet high, there are several smaller vents which are also active.

Next to Sapphire, Jewel and Avoca were the most important geysers in this basin. Jewel erupted about every 6 to 10 minutes to varying heights, 12 to 15 feet being about maximum. Avoca erupted every 1 to 3 minutes, the jets varying between 4 and 10 feet in height. It was the jarrings of the 1959 earthquake that turned this spring into, first a forceful steam vent, then a geyser.

Cascade Group

There are a large number of springs in this group, lying on both sides of the Firehole. As a result of the earthquake many of the unnamed springs on the west side of the river were turned into small geysers.

Seismic Geyser: Seismic is a new thermal unit. An earthquake-caused fumerole exploded during the winter of 1962-63 forming the present crater. A number of the geysers would seem to have had their origins due to earlier earthquakes of intensity equal to or greater than the 1959 one.

During the past two seasons Seismic has erupted about every 1 to 3 minutes. Usually there are several bursts during an eruption. An occasional burst jets up 30 to 40 feet.

Artemisia Geyser: At least one eruption of this geyser was observed daily. Occasionally it will have fairly short intervals. A 5½ hour one was noted during the season. This is unusual as it takes about 4 hours for the crater to refill following an eruption. Nearby Atomizer Geyser was frequently observed in an active phase.

During the season there was no observed shift of the thermal energy between Calthos and Gem Pools. There was steady overflow from Gem all season.

Morning Glory Group

Fan and Mortar did not erupt during the season. However, Spiteful Geyser which is known to be connected with the Fan and Mortar Complex was very active all season. The eruptions occurred about every 13 to 18 minutes, lasting about 90 seconds. The height is between 10 and 12 feet.

On October 9 East Sentinel Geyser erupted for the first observed time during the season. The height was about 20 feet. At times in the past this geyser has been very active. I have never observed it to erupt when there is high water in the Firehole River. West Sentinel is a steady geyser.

Grotto Group

Link Geyser: Link erupted to height of from 3 to 4 feet every 3 to 4 hours. An eruption lasts about 13 minutes. Link became dormant following the earthquake, rejuvenating again in 1963. There has been no known major eruption of Link since 1958. There was no geyser activity in any of the other springs in the Chain-Lake area.

Riverside Geyser: Except for a few days of digression in August, Riverside was very staid in its activity all season. The great majority of the eruption intervals were between 6 and 6½ hours. On August 19 it began erupting on near 5 hour intervals. The intervals slowly lengthened and by the end of the month it was back to the six-hour range. A sudden shift to shorter or longer intervals occasionally characterizes Riverside.

Table of Riverside's Activity for the 1967 Season

	<u>No. of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	24	6 hr. 30 min.	6 hrs. 39 min.	6 hrs. 0 min.
June	35	6 " 18 "	6 " 47 "	6 " 12 "
July	52	6 " 19 "	6 " 31 "	5 " 47 "
August	41	5 " 58 "	6 " 38 "	5 " 5 "
September	34	6 " 22 "	6 " 31 "	6 " 5 "
October	28	6 " 19 "	6 " 40 "	5 " 55 "

Grotto Geyser: Grotto's functioning is essentially the same as last season. Some eruptions last scarcely more than an hour while others last for the greater part of the day. The same is true of the quiet intervals. A long eruption is followed by a long quiet period.

One or more times during an eruption of Grotto it will pause and Rocket will jet heavy masses of water from 20 to 25 feet high. These eruptions last about 2 to 3 minutes. Nearby Spa, which is connected with the Grotto Complex, had but one known major eruption during the season.

Surprise Geyser: (Grotto Fountain): This geyser was not observed during May, but for the rest of the season it frequently acted as a precursor to an eruption of Grotto.

The eruptions this season were somewhat enervated compared to its previous activity and were of shorter duration, lasting from 13 to 15 minutes. On October 10 I observed that Surprise was boiling up 2 to 3 feet, indicating that it was in the throes of an impending eruption. Before it started Grotto began playing, stopping the eruption of Surprise. I have never seen this happen before. Invariably an eruption of Surprise was a precursor to an eruption of Grotto.

Giant Group

This group of springs remains in essentially the same state they have been in since the 1959 earthquake. There have been no observed signs of a possible shift of energy from Grotto to Giant. During most of the season Bijou has erupted steadily. However, beginning in late

August there have been occasional pauses in its activity. The water in Mastiff boiled more vigorously during the early part of the season. In the latter part of the season water occasionally sloshed up above the rim of Giant's crater. Catfish and Turtle were dormant.

Water stayed below overflow all season in the Purple Pools until October 13 when the south pool began discharging. During most seasons this pool is in a state of overflow most of the time. These pools are a part of the Giant Complex.

Oblong Geyser: So far as can be determined from records and personal observation, there has been only one recognizable change in Oblong's eruptive pattern since the time of its discovery and naming. Records indicate that most of its eruptions have occurred within a 6 to 8 hour range. For a few months following the earthquake of August 17, 1959 the output of thermal energy of Oblong was more than doubled. In September 1959, 47 eruption intervals were mechanically checked. The minimum interval was 2 hours and 29 minutes; the maximum 5 hours and 24 minutes.

By 1961 Oblong was erupting on essentially the same interval as before the earthquake and has continued to do so to date. The great majority of the eruptions during 1967 ranged between 6 and 8 hours. The maximum interval checked was 8 hours and 33 minutes; the minimum 5 hours and 30 minutes.

Since the earthquake the periods between exchange of function between Beauty and Chromatic Pools have been of longer duration than prior to the big jarrings. During the past season the overflow has been continuous from Chromatic, with about an inch of ebb in Beauty.

Daisy Group

So far as eruptive behavior is concerned this group is in a sad state compared with its prequake condition. Both of its major geysers are dormant due to a marked shift of the thermal energy to Bonita Pool, which shift resulted in heavy and constant overflow.

During the past season there has been some suggestion of a possible shift of the thermal energy back in the direction of Daisy. During the entire season Bonita would have two or more ebb periods every day during daylight hours for about a week, then it would go several days without any ebbing being observed. It was noted that there are two types of ebbing. In one the water level drops about 10 to 12 inches and stays below overflow about an hour. The other ebb only lasts about 30 minutes, with the level of the pool dropping from 4 to 6 inches.

When the overflow from Bonita ceases there is a rise in water level of all of the main springs to the west. There is a marked increase in the boiling of Daisy, Comet and Splendid. It is only at the time of the longer ebb of Bonita that Daisy overflows. If Bonita's ebb would persist a little longer in all probability Daisy would erupt.

Black Sand Basin

There has been some increase in the thermal energy of several springs in this basin over what was observed the three previous seasons. Cliff Geyser, Rainbow Pool and Sunset Lake have been more active. During June and July eruptions were observed in Sunset Lake. No eruptive activity has been observed in Green Spring for several seasons. The eruptive pattern of Spouter has remained essentially the same over the years.

Cliff Geyser: During June and July there were at least two eruptions each day during daylight hours. As the season progressed Cliff underwent a change I have never observed before. Instead of the crater refilling following the usual near three hour eruption, it would remain empty with almost continuous jetting, which would wax and wane in intensity. In July I saw an eruption start while there was still jetting from a previous eruption. The crater suddenly filled with water and the eruption started. The behavior was then typical of the initial stages of an eruption.

From July on the crater was never observed to fill. This resulted in Cliff not having a typical eruption; that is, progressing through the various stages of an eruption. The crater remained empty and there was near continuous jetting from the vent in the north side of the crater. There is no record of Cliff ever having performed in this manner before.

Myriad Group

Except for the Three Sisters, and an occasional eruption of Round Geyser, activity was quite stabilized in this group all season.

At the beginning of the season the crater of Three Sisters was full and overflowing in a manner similar to that which characterized it before the earthquake. In the early part of the season two vents in the north crater would erupt. The north vent would explode a large globule of water about 10 to 12 feet high. The eruption consisted of a single burst.

On June 27 of the current season water started to ebb in all craters. The ebb slowly progressed during all of July

Following the ebb, activity in the two north vents became less frequent. By early August it had ceased altogether. On August 8, Little Brother, located in the Three Sisters Complex, rejuvenated. It became dormant in 1965. Its eruptions were of about the same height as those during the early sixties, however, instead of 3 to 4 minutes duration they only lasted about half a minute. At the time Little Brother began erupting the east vent in the north crater also rejuvenated. By the end of the month it was dormant.

By the end of August activity began waning in Little Brother. By October it was again dormant. The water level in the south craters of Three Sisters is down about 15 inches.

During all of the season White Geyser erupted about every 2 minutes to a height of 10 to 12 feet, the eruption lasting for about 20 seconds. Several eruptions were observed of Round Geyser. Some of them were major in character - 40 to 50 feet in height, while others were about 10 to 12 feet in Height.

Castle and Sawmill Groups

The main hot springs near Castle showed no variation in their behavior all season. Crested Pool and Tortoise Shell Spring overflowed steadily. Periodically the boiling and overflow became heavier in Tortoise Shell. Tilt Geyser, near Crested Pool, erupted frequently. Some of the springs below Castle, along the river, as Sprinkler, Terra Cotta, and Spanker were periodically eruptive. The action in Spanker is steady.

Castle Geyser: During May and June the average interval on Castle was shorter than during the remainder of the season. Near the end of June a disturbance seemed to affect Castle, Grand and Three Sisters simultaneously. The average interval increased over half an hour on Castle and over three hours on Grand. The disturbance in Three Sisters has already been discussed. The fact that these three springs were apparently affected at the same time lends further evidence to possible subterranean connections between Castle and Grand. It is possible that a transverse fissure cuts across between Grand, Castle and the Myriad Group. They are in a direct line.

Preeruption symptoms of Castle begin about 90 to 120 minutes before it plays. However, occasionally heavy surging of water will precede the eruption any where from 3 to 4 hours, which always results in a longer interval. Castle has been known to go months without erupting with water continuously splashing above the rim of the crater. This has been referred to as the "sloppy stage".

Following an eruption of Castle instead of heavy splashes such as precede an eruption, spray mingled with steam is jetted every few seconds. This is a post-eruption symptom and should not be confused with the splashing which precedes an eruption. The spray and steam stage lasts about 3 hours.

Castle will occasionally have a short eruption, lasting from about 2 to 4 minutes, without going into the steam stage. When this happens the steam-phase eruption is delayed from about 2 to 4 hours. In September and October six short eruptions were known to occur.

Table of Castle's Activity for the 1967 Season

	<u>No. of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	18	8 hr. 30 min.	9 hr. 33 min.	8 hr. 15 min.
June	31	8 " 58 "	10 " 03 "	8 " 34 "
July	41	9 " 34 "	11 " 55 "	8 " 55 "
August	32	9 " 09 "	10 " 05 "	8 " 35 "
September	27	9 " 04 "	9 " 51 "	8 " 50 "
October	22	9 " 05 "	10 " 45 "	8 " 38 "

Several geysers across the river in the Sawmill Group displayed geyser activity during the season. These include Sawmill, Tardy, Spasmodic, Penta, Bulger and Deleted Tardy. In addition one eruption of Oval Spring was observed.

Sawmill Geyser was observed frequently in the early part of the season, but from about mid-June to August 8 no further eruptions were observed. During the period of quiescence Tardy erupted steadily and Penta Geyser had daily eruptions. It is definitely known that Tardy is connected underground with Sawmill, but connections between Sawmill and Penta have not been established with any certainty. However, behavior patterns of both geysers are highly suggestive of subterranean connections. From August 8 to the end of the season daily eruptions of Sawmill were observed but none of Penta and infrequent ones of Tardy.

Grand Group

Grand Geyser: During May and most of June Grand erupted on essentially the same pattern it did during the 1966 season, the average interval ranging between 8 and 9 hours. As closely as could be determined on June 27, of the current season, the Three Sisters, Castle and Grand showed indications of a disturbance which lowered the water level in Three Sisters and lengthened the intervals of Castle and Grand.

Not only were Grand's intervals lengthened, but they became erratic. This made it difficult to predict the time of an eruption with any degree of accuracy. The nature of the eruptions was not affected, it was the degree of interval range that aggravated the problem of prediction.

During July both Castle and Grand had longer intervals than during the remainder of the season. Beginning about August the intervals on both geysers decreased slightly and then seemed to level off for the rest of the season. Grand continued to be difficult to predict.

In the early part of the season Turban and Vent Geysers would drain following the last burst of Grand, but during most of the season action in Turban and Vent would continue about an hour before the first draining. This shifting back and forth in the Turban, Vent and Grand relationship has been characteristic over the years.

The observed number of separate bursts during an eruption of Grand ranged between 7 and 11. This again is typical behavior.

On August 20 Vent erupted independently of Grand and Turban. This is a certain precursor to an eruption of Grand. Vent's independent activity is of rare occurrence. There is no record of it prior to the 1959 earthquake. Previous to the August 20 occurrence it was last observed in 1964.

Table of Grand's Activity for the 1967 Season

	<u>No. of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	16	8 hr. 16 min	9 hr. 24 min.	6 hr. 36 min.
June	25	9 " 14 "	13 " 12 "	6 " 15 "
July	29	13 " 30 "	19+ hours	11 " 12 "
August	30	12 " 05 "	15 " 22 min.	8 " 0 "
September	20	12 " 34 "	15 " 0 "	11 " 25 "
October	16	11 " 56 "	15+ hours	9 " 25 "

Round Spring Group

The two small geysers in this group which are active most seasons were not observed to erupt during the current season. Both Round and North Round Springs overflowed constantly. This is the first season I have ever observed them to overflow simultaneously. During the great majority of seasons there is no overflow from North Round Spring.

Orange Spring Group

Three small, unnamed geysers in this group displayed frequent geyser activity during the season. The two geysers near the road were not observed to erupt during September and October.

Due to a parking spot and sign, "Approaching Old Faithful", having been placed right beside three important springs in the Orange Group, these springs have been subjected to a great deal of vandalism. The sign and parking area should be removed.

Geyser Hill

Many geysers, both large and small, are located on Geyser Hill. Of these Beehive and Giantess are the most famous, although both, especially Giantess, are quite erratic and infrequent in their eruptive activity. There have been periods, however, when Beehive has erupted with some degree of regularity.

Giantess Geyser: One or two eruptions a year seem to be about the best Giantess is capable of coming through with. There have been a few seasons, however, since the discovery and naming by the Washburn Party when several eruptions occurred during a season. During 1967 but one eruption has occurred to date. This activity was on May 4.

The above eruption began sometime during the night or early morning hours of the 4th. This eruption lasted for not less than 36 hours. It was the water-phase type with recurring surges of activity taking place about every 25 to 30 minutes. The active periods lasted from 3 to 5 minutes. During most eruptions the highest jets are attained during the early stage of the activity.

An important reason why Giantess erupts infrequently is due in big measure to the activity of many springs with which it is known to have subterraneous connections. During the past season Vault Geyser has been very active, the eruptions during most days taking place almost hourly. It is definitely known that Giantess is connected underground with Vault. An eruption of Giantess drains all the water from Vault. It takes 2 to 3 days for Vault to refill following an eruption of Giantess.

Many springs are very sensitive to changes in hydrostatic pressure. Part of the less frequent activity of Giantess over that of an earlier period might be due to the fact that it has built its mound to such a height (thereby increasing hydrostatic pressure) that the critical temperature of an eruption is seldom reached.

Lion Geyser: In the Lion Complex only Lion and Little Cub showed eruptive activity. Little Cub was active several times each day.

During the past season Lion went into an active phase about once each week. The active phase lasted for not less than two days. Once it lasted for three days. When in an active phase the eruptions occur about every one to two hours.

For a few seasons prior to the 1959 earthquake, Lion became infrequent in its eruptive periods. Before this decline it had been going into an active phase about every third day. Following the earthquake, and during all of 1960, there was a marked rejuvenation. It went into an active phase every second or third day. However, during most seasons since 1960 the eruptive periods have followed very much the same pattern as characterized them the past season.

Plume Geyser: For geysers of its size there is perhaps only one other in the Park that erupts with an equal degree of regularity as does Plume. This is Bead on the Firehole-loop Road.

Plumes eruptions occurred about every 25 minutes, with seldom more than two minutes variation.

Beehive Geyser: During 1967 more eruptions were recorded on Beehive than any season since 1960. The past season 26 eruptions were observed - one in April, 5 in May, 4 in June, 8 in July, 5 in August, 2 in September and 1 in October. As indicated, there was a noted decline in its activity the latter part of the season. The longest interval was between September 17 and October 21. The shortest interval was between May 23 and May 24 - 21 hours.

It is believed that the 26 eruptions represent the total amount of its activity this season. The absence of splashing water for a period of not less than ten hours following an eruption leaves the cone a bleached color. It looks very much as if it had been whitewashed. Castle and Grotto show the same effect.

Beehive was very active following the earthquake. During 1960, 103 eruptions were recorded, and it was assumed that it played an additional 37 times during the night.

Other named springs on Geyser Hill which erupted during the 1967 season are Depression, Bench, Midget, Cone, Infant, Sponge, Aurum, Beach, Anemone, and Little Squirt.

Old Faithful Geyser: Old Faithful followed essentially the same pattern all season. On those days when there were two or more eruptions much under average the daily average was less than on those days when all the eruptions were near and above average.

Two times during the season the small geyser on the low mound that abuts Old Faithful's on the west was observed erupting.

Table of Old Faithful's Activity for the 1967 Season

	<u>No. of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	163	66.6 min.	85 min.	37 min.
June	285	66.3 "	90 "	39 "
July	336	66.3 "	85 "	41 "
August	334	66.4 "	90 "	42 "
September	218	65.5 "	91 "	36 "
October*	201	66.4 "	91 "	42 "

* Through the 26th

1968

Hot Spring Activity In The Geyser Basins Of The
Firehole River For The 1968 Season

George D. Marler

Geyser activity was known to occur in the following named hot springs during 1968:

LOWER BASIN

Great Fountain Group

- | | | |
|-----------------------------------|----------------------|------------------|
| 1. Great Fountain Geyser | 2. White Dome Geyser | 3. Gemini Geyser |
| 4. Pebble Geyser (suggested name) | | |

Pink Cone Group

- | | | |
|---------------------|---------------------|---------------|
| 1. Pink Cone Geyser | 2. Narcissus Geyser | 3. Box Spring |
| 4. Bead Geyser | | |

Firehole Lake

- | | |
|------------------|-------------------------|
| 1. Steady Geyser | 2. Young Hopeful Geyser |
|------------------|-------------------------|

Fountain Group

- | | | |
|---------------------|----------------|----------------|
| 1. Clepsydra Geyser | 2. Sub Geyser | 3. Mask Geyser |
| 4. Jelly Geyser | 5. Red Spouter | 6. Twig Geyser |
| 7. Jet Geyser | 8. Fountain | 9. Spasm |

Hotel Group

- | |
|------------------|
| 1. Kidney Geyser |
|------------------|

Kaleidoscope Group

- | | | |
|------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
|------------------------|---------------------|---------------------|

Morning Mist Group

- | | |
|------------------------|--------------|
| 1. Morning Mist Geyser | 2. The Snort |
|------------------------|--------------|

Twin Buttes

- | | |
|--------------------|-----------------|
| 1. Imperial Geyser | 2. Spray Geyser |
|--------------------|-----------------|

MIDWAY BASIN

- | | | |
|-------------------|----------------------|----------------------|
| 1. Catfish Geyser | 2. East Flood Geyser | 3. West Flood Geyser |
| 4. Tromp Spring | 5. Mud Spring | 6. River Geyser |

UPPER BASIN

Biscuit Basin

- | | | |
|-----------------------|-----------------------|------------------------|
| 1. Cauliflower Geyser | 2. Shell Geyser | 3. West Mustard Spring |
| 4. Sapphire Pool | 5. Avoca Spring | 6. Island Geyser |
| 7. Jewel Geyser | 8. Black Pearl Geyser | 9. North Geyser |
| 10. Rusty Geyser | 11. Silver Globe | |

Cascade Group

- | | | |
|---------------------|-------------------|--------------------|
| 1. Artemisia Geyser | 2. Seismic Geyser | 3. Atomizer Geyser |
|---------------------|-------------------|--------------------|

Morning Glory Group

- | | | |
|-------------------------|--------------------|-------------------------|
| 1. East Sentinel Geyser | 2. Spiteful Geyser | 3. West Sentinel Geyser |
|-------------------------|--------------------|-------------------------|

Grotto Group

- | | | |
|------------------|--------------------------|---------------------|
| 1. Grotto Geyser | 2. Surprise Geyser | 3. Riverside Geyser |
| 4. Rocket Geyser | 5. South Surprise Geyser | 6. Spa Geyser |
| 7. Link Geyser | | |

Giant Group

- | | |
|-----------------|------------------|
| 1. Bijou Geyser | 2. Oblong Geyser |
|-----------------|------------------|

Grand Group

- | | | |
|------------------|----------------|------------------------|
| 1. Grand Geyser | 2. Vent Geyser | 3. West Triplet Geyser |
| 4. Turban Geyser | 5. Rift Geyser | |

Castle and Sawmill Groups

- | | | |
|-------------------|----------------------|-----------------------|
| 1. Castle Geyser | 2. Spasmodic Geyser | 3. Spanker Geyser |
| 4. Tilt Geyser | 5. Tardy Geyser | 6. Oval Spring |
| 7. Sawmill Geyser | 8. Bulger Geyser | 9. Deleted Tardy |
| 10. Penta Geyser | 11. Sprinkler Geyser | 12. Deleted Teakettle |

Black Sand Basin

- | | | |
|-------------------|-----------------|----------------|
| 1. Spouter Geyser | 2. Cliff Geyser | 3. Sunset Lake |
| 4. Whistle Geyser | | |

Daisy Group

- | | | |
|-----------------|--------------------|-------------------------|
| 1. Comet Geyser | 2. Bank Geyser | 3. White Pyramid Throne |
| 4. Daisy Geyser | 5. Splendid Geyser | 6. Daisy's Thief |

Myriad Group

Three Sisters:

- | | | |
|------------------|-----------------|-----------------|
| 1. Middle Crater | 2. Round Geyser | 3. White Geyser |
|------------------|-----------------|-----------------|

Giantess Group

- | | | |
|-------------------------|-------------------------|---------------------|
| 1. Little Squirt Geyser | 2. Little Cub | 3. Vault Geyser |
| 4. Anemone Geyser | 5. Lion Geyser | 6. Giantess Geyser |
| 7. Surge Geyser | 8. Goggle Spring | 9. Infant Geyser |
| 10. Plume Geyser | 11. North Goggle Spring | 12. Solitary Geyser |
| 13. Beehive Geyser | 14. Beach Spring | 15. Bench Geyser |
| 16. Depression Geyser | 17. Aurum Geyser | 18. Dome Geyser |
| 19. Sponge Geyser | | |

Old Faithful Group

1. Old Faithful

Lone Star Group

1. Lone Star

Biscuit Basin

During the current season the activity of all springs in this basin seemed to undergo very little change. Island Geyser and several nearby vents which began erupting in May 1966 continue to play without any known cessation. After the 1959 earthquake the above springs greatly increased in temperature, but no observed erupting occurred until May 1966.

Rusty Geyser was very active all season. During the first half the eruptions occurred about every 4 to 5 minutes, the height being about 10 to 12 feet; duration about one minute. In the latter part of the season boiling was almost constant. Eruptions about 3 feet high occurred about every minute.

Sapphire Pool: During 1968 Sapphire has shown evidence of reverting back to its pre-earthquake function as well as its lovely sapphire color. By October the eruptions were occurring about every 15 to 17 minutes, the height being about 3 feet. The discharge now goes out of the west side of the crater, then to the south. Formerly the drainage was to the east. Large blocks of sinter that were torn from out the west side of the crater have lowered the level of the pool about 6 inches. This results in steady overflow. Previous to the earthquake the overflow was only at the time of an eruption.

Black Pearl and Coral Geysers appear to be dormant. There is no evidence of eruptive activity during the current season. The water is still down about 4 feet in Mustard Spring. The west one continues to have steady, sub-aerial eruptions. Water has jetted up about 18 inches almost constantly in North Geyser. Some seasons it has periodic eruptions, about 15 to 20 feet high.

Avoca Spring: As a result of the 1959 earthquake this spring was converted, first into a steam vent, and then a geyser. The eruptions are becoming more forceful and the intervals longer. Currently it is erupting 12 to 15 feet high every 15 to 20 minutes. Following the earthquake nearby Silver Globe spring emptied. Since the quake there has been a gradual rise in water level; also occasional minor eruptive activity.

Shell Geyser shows less evidence of eruptive activity than during any season since the 1959 disturbance. Jewel Geyser erupts every 6 to 10 minutes to heights varying between 10 and 15 feet.

Cascade Group

Following the 1959 earthquake eleven springs on the west side of the river were converted into geysers. During 1968 only two of them, both unnamed, continued to show eruptive activity.

Seismic Geyser: Since Seismic came into being in 1963 it is not only slowly enlarging its crater, which was formed due to an explosion, but the pattern of activity is also undergoing change. Presently the intervals seem to range between about 40 and 50 minutes. An active phase at times will last 15 minutes and more.

The eruptions consist of a series of explosions. Most of the bursts are 10 to 15 feet high. However, there are occasional bursts 30 to 40 feet high.

The development of Seismic as a geyser has apparently produced a marked change in two nearby springs. Before present eruptive activity of Seismic, Hillside Geyser was active about every 15 minutes. It is now dormant, with its water about 15 degrees lower in temperature. On the bench above Seismic there are two large springs in which the water level has dropped about 10 feet. This drop has occurred since the birth of Seismic. The drop in water level seems to still be in progress. Seismic's subterranean connections will in all probability result in future cyclic activity.

Seismic is not only a strictly new geyser, it is an interesting one to observe in action. The broken sinter and dead trees about its crater tell an interesting story. It is this change, which is ever taking place in the geyser basins, that helps to make the hot springs intriguing to the interested observer. Alas, for all too many, even the eruptions of major geysers are altogether too prosaic.

Artemisia Geyser: An eruption of this geyser consists of a series of explosions. The active phase lasts for about 13 minutes. Many of the bursts are from 25 to 35 feet in height. It takes the crater about 4 hours to refill to overflow following an eruption. I have never been able to observe any premonitory signs of an eruption, except the sudden rise in water level and heavy discharge which precedes the eruption by less than a minute.

Atomizer Geyser: During an active pahse this interesting geyser has a series of eruptions. The series is characterized by eruptions of 40

to 50 seconds duration which play to a height of about 20 feet. Four or more such eruptions occur to be followed by the concluding performance. The last eruption in the series lasts for about 30 minutes; the height being from 30 to 40 feet. There is a concluding steam phase. It is only at the time of the last eruption that any activity takes place in the north cone. This activity is mostly steam ejection.

Morning Glory Group

There was no eruption of Fan and Mortar during the 1968 season. In spite of "Keep Off" signs considerable vandalism took place, mostly in the nature of breaking off sheets of sinter, some of which were thrown into the geysers. Mortar was the principal recipient. Morning Glory was also a victim of considerable abuse. The crater is a reflection of the thoughtlessness and lack of appreciation of countless visitors. Morning Glory will not indefinitely withstand the stream of debris that pours into it each season. There was no observed major activity in Sentinel Geyser. Spiteful was active, erupting every 13 to 25 minutes.

Grotto Group

Riverside Geyser: Riverside erupted with marked regularity all season. The great majority of the eruptions occurred between 6 hours and 15 minutes and six hours and 25 minutes.

Table Showing Riverside's Activity for the 1968 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	45	6 hr. 22 min.	6 hr. 33 min.	6 hr. 4 min.
June	64	6 hr. 15 min.	6 hr. 26 min.	6 hr. 0 min.
July	75	6 hr. 23 min.	6 hr. 58 min.	6 hr. 6 min.
August	96	6 hr. 18 min.	6 hr. 35 min.	6 hr. 11 min.
September	69	6 hr. 17 min.	6 hr. 30 min.	6 hr. 5 min.
October	38	6 hr. 11 min.	6 hr. 19 min.	6 hr. 0 min.

Grotto Fountain: (Surprise Geyser) In the latter half of the season this geyser was observed in action on but few occasions. It was quite active in May, which was just the opposite of May 1967. An eruption of this geyser is a certain precursor to an eruption of Grotto. Its history is one of long periods of dormancy.

Grotto Geyser: During 1968 Grotto performed essentially the same as during the 1967 season. The eruptions as well as the quiet periods vary considerably in length. So far as could be determined there was at least one eruption of Rocket during each eruption of Grotto. Of the two, Rocket is the more spectacular performer. No Major eruptions were noted in Spa which is a part of the Grotto complex.

Link Geyser: Link was the only geyser in the Chain Lake area to show any eruptive activity. The eruptions occur about every 3 to 4 hours, lasting about 13 minutes. The height is 3 to 4 feet. Considerable water is discharged.

During the 1950's there were seasons when Link displayed major activity. The last known period of major eruptions was during the 1958 season when many eruptions were observed. It was one of few geysers which the 1959 earthquake did not stimulate into major activity.

On September 19, at 2:00 pm Link unleashed one of its major power displays. There was a follow-up eruption that night. I feel confident this was the first activity of this type since the 1958 season. Evidence about the crater of major activity is apparent for several months following an eruption.

A major eruption lasts for about 2 minutes. Several thousand gallons of water are discharged. The eruption angles to the northwest, projecting a heavy column of water to a height of not less than 75 feet.

Giant Group

There has been little or no change in this group since the 1959 earthquake. During all of the current season Bijou has erupted almost constantly. A few pauses were noted. Occasionally water would splash above the rim of the bowl of Catfish. Continuous boiling and occasional surging above the rim of the crater characterized Giant. Across the river from Giant and connected subterraneously with it, are the Purple Pools. The south one overflowed all season, discharging between 40 and 50 gallons per minute.

Oblong Geyser: During the latter part of the season Oblong was not observed in an eruption as frequently as during the early part of the

season. The determined intervals ranged between about 4 and 8 hours. Automatic recorders placed at Oblong, and especially Artemisia, would serve very useful purposes in getting data on these geysers.

During the past season the overflow has been continuous from Chromatic with about an inch of ebb in Beauty.

Round Spring Group

The three small unnamed geysers in this group were not observed to erupt during 1968. The removal of the sign "Approaching Old Faithful" has reduced vandalism in this group.

Daisy Group

Hopes for a rejuvenation of Daisy were somewhat brightened this season by 10 known eruptions. The first eruption was on July 31, the others were in September. No eruptive activity occurred during October.

Bonita Pool did not ebb as frequently during 1968 as in 1967. However, following the July eruption of Daisy there was a definite shift of some of the thermal energy to the west. The water level rose about 2 inches in all related springs. There was a noticeable increase in boiling in Daisy, resulting in a slight overflow from the crater due to splashing.

On all but two known occasions Daisy's Thief acted as a precursor to an eruption of Daisy. An eruption of the Thief signaled one or more eruptions of Daisy.

On the night of September 19th there was an eruption of Splendid. This is the first known activity since the 1959 earthquake. At times Splendid appears very hot. Water will splash up 10 to 20 feet.

On the 18th of September there were 16 known earth tremors at Old Faithful. The early ones were of sufficient intensity to be heard, and the disturbance to, or creaking of the District Office was very noticeable. The above is mentioned in view of the fact that several hours later both Link and Splendid Geysers erupted. This might well be pure coincidence, but the fact that the big quake induced eruptions in numerous quiescent springs lends an element of possibility that the eruptions referred to and the earth tremors were related phenomena.

Black Sand Basin

The unnamed spring near the walk to Emerald Pool boiled constantly all season. Three eruptions were observed. The water is jetted to a height of about 15 feet. There was steady overflow from Green Spring, but no evidence of eruptive activity. Emerald Pool displays the same color hue, a dull, dark green, as has been its habit for several years. An increase of about 5 degrees in temperature would restore the bright emerald color. Occasionally there was slight overflow from Rainbow Pool. The algae in the crater are a dark brown color. During the first half of the season a few minor eruptions in Sunset Lake, with an occasional surge to 8 to 10 feet were observed. From August on no activity was noted.

Cliff Geyser: There was much less activity during 1968 in Cliff than occurred in 1967. No eruptions were observed in the latter part of the current season. The lack of activity in Cliff and Sunset Lake was perhaps due to the same cause.

The water level in Opalescent Spring stayed at the top of the crater all season. This was no doubt due to a greater diversion of water from Spouter Geyser.

Whistle Geyser: One eruption of this geyser occurred on August 13. This was the first known activity since the 1956 season. The water phase of Whistle does not last for more than a minute, but the steam phase has been known to last for 2 to 3 hours. The steam phase of this season's eruption only lasted for half an hour.

Following the August activity it was a week before the bowl refilled. The water for several weeks would periodically rise and drop. By October there was steady seepage from the crater.

Myriad Group

The drop in water level which occurred in 1967 in the Three Sisters persisted throughout most of the 1968 season. For a brief period in September the north crater filled to near overflow, then dropped about a foot below the rim. There was no geyser activity in the north crater this season; Little Brother also remained dormant. There was a steady flow of water from the middle crater to the north one. Occasionally the middle crater would erupt. The activity consisted of a few surges with little water being discharged, except into the north crater.

Round Geyser was observed erupting on several occasions. More activity was noted in the first part of the season. An eruption lasts for scarcely more than a minute, the water being projected to a height of from 40 to 50 feet. During the quiet phase there is light overflow. There seem to be no premonitory signs of an eruption. The water suddenly bulges and the eruption is underway. It takes from 7 to 9 hours for the crater to refill following an eruption.

White Geyser erupted on essentially the same pattern as during 1967. The eruptions occurred about every one to two minutes, lasting for a few seconds.

Castle and Sawmill Groups

The main springs near Castle showed little variation all season. One minor eruption on July 5th was observed in Crested Pool. The water boiled up from one to two feet. This kind of action is seldom noted in this spring. There is evidence it is connected underground with Castle. Terra Cotta Spring and Sprinkler Geyser displayed frequent geyser activity. No action was reported in Tilt Geyser after May.

Castle Geyser: The action of Castle during all of the 1968 season showed little variation. Most of the intervals were between 8 and a half and nine hours. At times there were longer intervals. Several short eruptions of 2 to 4 minutes duration occurred. These eruptions are without a steam phase. They delay a steam-phase eruption by about 4 hours.

Table of Castle's Activity for the 1968 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	36	8 hr. 50 min.	10 hr. 50 min.	8 hr. 29 min.
June	48	8 hr. 42 min.	10 hr. 31 min.	8 hr. 30 min.
July	62	8 hr. 55 min.	12 hr. 10 min.*	8 hr. 25 min.
August	64	9 hr. 5 min.	10 hr. 48 min.	8 hr. 35 min.
September	57	9 hr. 2 min.	11 hr. 10 min.	8 hr. 28 min.
October	42	9 hr. 3 min.	11 hr. 15 min.	8 hr. 46 min.

In giving maximum and minimum intervals only steam-phase eruptions are considered.

*The long 12 hours and 10 minutes interval on July 5 was apparently due to the minor activity in Crested Pool.

Across the river from Castle, in the Sawmill Group, geyser activity was observed in a number of hot springs, including Deleted Teakettle, Tardy, Spasmodic, Churn, Penta, Deleted Tardy, Bulger and Sawmill. A number of eruptions of Penta were noted in May and June, but none in the remainder of the season.

Sawmill Geyser: In the early part of the season Sawmill was dormant. When first observed in May the state of the sinter about the crater was indicative there had been no geyser activity for several weeks. The first observed eruption was on July 17. From then on there was occasional activity, becoming more frequent as the season progressed.

Grand Group

Grand Geyser: There was little variation in Grand's eruptive pattern during the whole of the season. The majority of the eruptions were predictable within a 2 hours range. The average time was near 11 hours. Occasionally much longer and much shorter intervals would occur. The two most disturbing influences resulting in longer intervals for Grand seem to be eruptions of West Triplet and Rift Geysers. The cause of the short intervals is not readily apparent.

Following the great majority of Grand's eruptions Turban and Vent would continue erupting for about an hour before their first cessation of activity. Why during many periods and seasons Turban and Vent will reverse this performance and always cease erupting for about half an hour following Grand's last burst and then resume activity is quite inexplicable. It is usually about 3 hours following an eruption of Grand before the last active phase of Vent ceases and Turban resumes activity without Vent's concert play.

Table of Grand's Activity for the 1968 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	25	12+ hrs.	14+ hrs.	8 hr. 40 min.
June	32	11 hr. 30 min.	15 hr. 5 min.	8 hr. 23 min.
July	34	11 hr. 36 Min.	14 hr. 32 min.	8 hr. 25 min.
August	64	10 hr. 48 min.	15 hr. 33 min.	8 hr. 3 min.
September	42	10 hr. 45 min.	15 hr. 10 min.	8 hr. 28 min.
October	24	11 hr. 16 min.	12 hr. 12 min.	9 hr. 30 min.

Geyser Hill

Of the larger geysers Plume, Beehive and Lion seemed to hold the spotlight during the season. This was especially true of Beehive. There was one eruption of Giantess.

A number of small geysers were quite active. Little Squirt would show activity for relatively long periods and then have long quiet phases. The water in nearby Bronze Spring was down about 6 inches. Sulphide had steady overflow, discharging about 3 gallons per minute. The south vent of Anemone was active most of the time with frequent periodic activity occurring in the north vent. No action was noted in Surge Geuser after May. Bench was active about every 2 to 3 minutes. Roof erupted about every 5 minutes. There were occasional eruptions of North Goggle, Beach, Aurum and Dome.

Following the 1959 earthquake the level of the water in Dragon Spring dropped about 18 inches. Previous to the quake there was steady overflow. At the beginning of the 1968 season it was again overflowing, the first time since the 1959 drop.

Sometime during the summer two minor explosions near the southwest base of Sponge Geyser opened up small craters about 2 feet wide. The crater to the southeast opened up a new spring while the one on the southwest base of Sponge enlarged the crater of an already existing small geyser. On one occasion the southeast vent was observed to erupt to a height of about 15 feet.

Lion Complex: There are 4 important springs in this group: Lion, Lioness, Big Cub and Little Cub. There is also a small geyser near the west base of the group.

During the season Lion was in an active phase twenty times. An active phase lasts from about 12 to 48 hours, during which an eruption occurs about every one to two hours. Big Cub and Lioness did not erupt. However, the water stood higher in the crater of Lioness than it has for several seasons. Little Cub erupted several times each day.

Plume Geyser: The vent that developed a few years ago on the west side of Plume continues to grow. The fact that it erupts simultaneously with Plume might suggest that if there is further enlargement of its crater it will eventually alter the present nature of Plume's function. During the current season Plume's intervals varied between 25 and 29 minutes.

Dome Geyser: This geyser was never observed to erupt prior to the 1959 earthquake. During the current season it was active on the 5th of May and again on August 17 and 18. When in an active phase several eruptions occur. In August an unnamed spring near the north base of Dome erupted quite violently.

Giantess Geyser: An eruption was first observed at 7 a.m. on May 3. It began during the early morning hours, and lasted for not less than 36 hours. As if by coincidence it erupted on May 4, 1967. Its only other known eruption between these dates was on January 28, 1968. The eruption was a typical water-phase type. Recurring periods of activity took place about every 30 to 60 minutes. Infant Geyser was active during the active period of Giantess.

Beehive Geyser: This impressive geyser was unusually active during the 1968 season. There were 77 eruptions recorded, as against 26 eruptions for the same period in 1967. Like the 1967 season during 1968 there was a period of decline in eruptive activity during the latter part of the season.

The number of eruptions occurring each month is as follows: May - 7, June - 18, July - 16, August - 15, September - 9, October - 12. As will be noted its greatest activity occurred during June. On five separate days it erupted twice during daylight hours. On two dates, the 17th and 26th, it erupted 3 times in a 20 and 21 hour period. So far as available records are concerned this number of eruptions occurring during so short a period is unprecedented. During August two eruptions were observed during daylight hours of the same day.

While there was unprecedented, that is previously unrecorded, short-period activity during June 1968, the number of eruptions during the month did not equal that for December 1951, or January and February 1952. The greatest number of eruptions ever recorded on Beehive occurred from November first 1951 through April 1952. Per month they are as follows: November - 18, December - 24, January - 22, February - 20, March - 18, April - 11, making a total of 113 eruptions.

During the season there was an interesting pattern in Beehive's activity. In June, July and August most of the eruptions occurred about every third day. Then there would be a follow-up eruption about 10 to 24 hours later. This follow-up pattern with a second eruption during a 24 hour period was characteristic for September and October.

The indicator was active preceding most of the eruptions. It began functioning anywhere from about 10 minutes to over 40 minutes before the eruption. The indicator is not an infallible assurance that Beehive will shortly erupt. On several occasions the indicator functioned without a follow-up eruption of Beehive.

Table of Old Faithful's Activity for the 1968 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	218	65.5 min.	88 min.	43 min.
June	315	65.1 min.	88 min.	38 min.
July	348	65.1 min.	88 min.	41 min.
August	352	65.9 min.	86 Min.	37 min.
September	240	66.2 min.	92 min.	40 min.
October	266	64.8 min.	88 min.	33 min.
Total	1739	65.4 min.	92 min.	33 min.

During 1967 there were 1537 intervals determined on Old Faithful. The monthly average was 66.25 minutes; the maximum interval 91 minutes; the minimum 36 minutes.

MIDWAY GEYSER BASIN

This basin has very few active geysers. Those which were observed to erupt during the season were Flood, West Flood, River Geyser, Mud Spring, Tromp and Catfish. An unnamed spring near River Geyser erupted several times each day. On two occasions I saw Flood and West Flood erupting simultaneously. This is the first season I have seen this happen. The bowl of the large, unnamed spring north of Flood has filled for the first time since the big drop following the 1959 disturbance.

No change was noted in Excelsior, Grand Prismatic or Turquoise. However, Opal Spring has refilled with a marked overflow. At times it has been observed to erupt. The state of the geyserite about the crater is indicative of a considerable amount of geyser activity during an early and unrecorded period.

LOWER GEYSER BASIN

The springs about the base of South Twin Butte are the most widely separated from the main groups of springs in this basin. There are geysers on both the east and south sides of this Butte. The Butte is a huge moraine. It is believed it rests on pre-glacial hot springs. The largest geyser is at the base of South Twin Butte. It was first noted in eruptive activity during the 1928 and 1929 seasons. It was named Imperial. It became dormant following 1929 with no further activity until 1966. During this season, and to date, it has remained a steady geyser. It is one of but few geysers which did not erupt following the 1959 earthquake.

River Group

Ojo Caliente continues to erupt in essentially the same manner as it did in the latter part of the 1967 season. It is believed that the geyser activity which was initiated in this spring was the direct result of a nearby test hole put down by the U.S.G.S. It was during the drilling that the eruptions started.

Skeleton Pool seems to be having difficulty recovering from the big earthquake. Its water level is still down 6 to 8 inches. But one named geyser in this group, Mound, was seen in eruptive activity during the season. Three other small unnamed geysers were periodically active. The enlarging group of mud springs on the east side of Pocket Basin, and near the River Group, make this an interesting area.

Sometime in early August an unnamed spring in the meadow south of Mound Geyser erupted. The action appeared new and was quite violent. Much fragmental sinter was disgorged from the crater.

Hotel Group

Of the 10 hot springs in this group only Kidney showed any geyser activity. In the groups of hot springs about the Porcupine Hills only Snort and Morning Mist were known to erupt.

Kaleidoscope Group

There are a great many geysers in this group. Most of them are small. A number are cyclic in their activity. As a result of the 1959 earthquake a great many hitherto inactive springs were induced into eruptive activity. In at least 4 of them the activity is persisting.

The most noted geyser in the group is Kaleidoscope. It is cyclic in its activity. There are periods, several years in length, when the thermal energy will shift to a nearby spring into which most of Kaleidoscope's water flows. When this shift occurs the hitherto inactive spring is periodically active, resulting in a dormant Kaleidoscope.

Kaleidoscope was very active during the current season. The intervals ranged between about 2 and 9 minutes. When the play is shorter the interval is shorter. A spring a short distance west from Kaleidoscope erupted frequently. Geyser activity was also noted in Honeycomb and Deep Blue.

Fountain Group

Over the years this group has been by far the most famous in the Lower Basin. This in the greater measure has been due to the Fountain Paint Pot and to a lesser degree, Fountain Geyser.

With but one known exception Celestine Pool and Silex Spring overflowed steadily all season. In early September the water in Silex ebbed about 14 inches below the rim of the crater. During some seasons this ebb will occur one or more times per week, lasting from 2 to 3 hours. The flow from Silex has been almost constant since the big quake. Both Celestine and Silex have been known to erupt.

Fountain Paint Pot: Except for a few inches rise in level during the heavy August precipitation there was no observable change in its usual seasonal activity. The new mud springs under the old walk are still very active. They came into being as a result of the 1959 earthquake.

Red Spouter: This new mud spring is still in the process of enlarging its crater. In the beginning (1959) there was but one vent. Now there are three. Currently most of the activity is in the west vent. Due to heavy August rains this spring for a period of about two weeks reverted from the steam to the liquid phase. This indicates a delicate balance between ground water and the source of energy. At the end of October it was still in the steam phase.

Fountain and Morning Geysers: Some time during the past winter Fountain rejuvenated. This was the first known activity since 1964. It was rendered dormant by the big earthquake. It rejuvenated in 1963.

The activity in the early part of the season was essentially the same as that following its rejuvenation. The eruptions occurred about every 12 minutes, lasting from 3 to 4 minutes. The height of the bursts was from 6 to 15 feet.

During June Fountain began having occasional major eruptions; the height being from 30 to 40 feet. Minor eruptions became less frequent as the season progressed. During the latter part of the season only major eruptions were observed; the intervals being about 6 hours.

Morning was dormant all season. In fact the water in the main crater never got above 150°F. Much of the water of a major eruption of Fountain would fill the crater of Morning. Its own supply of water, if any, was very small. Following each major eruption of Fountain the water in Morning would drop about 4 feet. The central craters were full of dark brown algae.

Clepsydra Geyser: This geyser persists in its earthquake response. During some seasons since 1960 there has been cessation of activity in the steam vent. This vent is the one farthest to the northwest and erupts at an angle. During the current season, however, the steam vent has been a part of all activity observed. It produces quite a pronounced roar.

Following most of Fountain's eruptions there would be a momentary pause in Clepsydra's activity. Once in September it was quiescent for over an hour.

Other named geysers in the Fountain Group that were active during the season include Spasm, Jelly, Twig, Sub. Jet and Mask. Spasm was very active during May and June, but was not observed to erupt during the latter part of the season. A new crater has developed on the east side of its bowl. Like Spasm, early season activity characterized Jet and

Twig. In the latter part of the season they were dormant. Sub erupted about every 5 minutes, with occasional longer intervals.

Firehole Lake

The new geyser on the edge of Firehole Lake boiled steadily all season. Young Hopeful erupted steadily from the middle of the season to the end. The pressure at Young Hopeful was above that of the average season, as water jetted continuously from 3 additional vents.

Steady Geyser: This geyser is characterized by having two orifices. Over the years there apparently has been an exchange of function between these vents. The vent on the side of the cone next to the lake has been the most active during the period I have observed this geyser. Following the earthquake the eruptive activity shifted to the side vent. Three large transverse cracks formed across the cone. I surmised that the upper vent, so far as eruptive activity was concerned, was completely out of the picture. However, during most of the current season both vents have been erupting simultaneously. During late August and most of September the upper vent got progressively stronger. In late September it ceased all activity and was dormant for the rest of the season.

Pink Cone Group

All springs in this group have at times displayed geyser activity. Pink Cone, Bead and Narcissus are the largest geysers and the most consistent performers. They erupted on essentially the same pattern as in 1967. Five unnamed geysers were active during the current season. However, Box Spring was not only inactive, but the water was down about 4 feet in the crater all season.

Great Fountain Group

White Dome: This geyser played with greater frequency than during 1967. Twenty-four minutes was the shortest interval checked in 1967, whereas 15 to 17 minute intervals were common during the current season. Two small geysers west of White Dome displayed frequent geyser activity.

On the morning of the 14th of August when I reached White Dome I noted that pebbles were strewn across the road due to recent eruptive activity

of a spring a few feet south of Gemini Geyser. This spring borders the shoulder of the road. It had its crater largely filled with gravel due to recent inadvertent road construction. The great amount of gravel disgorged has suggested the name Pebble Geyser.

Periodically Pebble has continued to erupt since its initial August house cleaning of rocks. Rocks are still being disgorged.

Great Fountain: Except for a short period in mid-August, Great Fountain erupted with marked regularity all season. The period referred to above occurred on August 17. On this date it was noted that the water in the crater was down at least 9 feet below the rim. It stayed at this low level for the remainder of the day. On the following day it would periodically overflow, then ebb. No eruptive activity occurred on the 17th. By the 18th it was erupting normally again but on slightly longer intervals. The overflow preceding an eruption was also longer. Premonitory boiling was altered. By the middle of September conditions were essentially the same as preceding the August disturbance.

The above described condition at Great Fountain has been observed to occur on a number of previous occasions. All such observations were made during the month of November. It was surmised this condition was probably due to a cooler body of ground water which seems to reach the Lower Basin at this time of the year. The August ebbing and lack of eruptive activity lend support to the above view, due to the fact that nearly 5 inches of rain fell during the first two weeks of August. No systematic observations of Great Fountain have yet been made from December to mid-April.

Table of Great Fountain's Activity for the 1968 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	18	7 hr. 25 min.	9 hr. 25 min.	6 hr. 55 min.
June	42	7 hr. 36 min.	9 hr. 16 min.	7 hr. 28 min.
July	82	7 hr. 30 min.	9 hr. 20 min.	5 hr. 30 min.
August	78	8 hr. 02 min.	9 hr. 12 min.	6 hr. 41 min.
September	58	7 hr. 58 min.	9 hr. 18 min.	7 hr. 00 min.
October	24	7 hr. 45 min.	8 hr. 15 min.	7 hr. 25 min.

1969

Hot Spring Activity In The Geyser Basins Of The
Firehole River For The 1969 Season

George D. Marler

Geyser activity was known to occur in the following hot springs
during 1969:

LOWER BASIN

Great Fountain Group

- | | | |
|-----------------------------------|----------------------|------------------|
| 1. Great Fountain Geyser | 2. White Dome Geyser | 3. Gemini Geyser |
| 4. Pebble Geyser (suggested name) | | 5. Crack Geyser |

Pink Cone Group

- | | | |
|---------------------|---------------------|----------------|
| 1. Pink Cone Geyser | 2. Narcissus Geyser | 3. Bead Geyser |
|---------------------|---------------------|----------------|

Firehole Lake

- | | |
|------------------|-------------------------|
| 1. Steady Geyser | 2. Young Hopeful Geyser |
|------------------|-------------------------|

Fountain Group

- | | | |
|---------------------|----------------|----------------|
| 1. Clepsydra Geyser | 2. Sub Geyser | 3. Mask Geyser |
| 4. Jelly Geyser | 5. Red Spouter | 6. Twig Geyser |
| 7. Jet Geyser | 8. Fountain | 9. Spasm |

Hotel Group

- | |
|------------------|
| 1. Kidney Geyser |
|------------------|

Kaleidoscope Group

- | | | |
|------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
|------------------------|---------------------|---------------------|

Morning Mist Group

- | | |
|------------------------|--------------|
| 1. Morning Mist Geyser | 2. The Snort |
|------------------------|--------------|

Twin Buttes

- | | |
|--------------------|-----------------|
| 1. Imperial Geyser | 2. Spray Geyser |
|--------------------|-----------------|

MIDWAY BASIN

- | | | |
|-------------------|----------------------|----------------------|
| 1. Catfish Geyser | 2. East Flood Geyser | 3. West Flood Geyser |
| 4. Tromp Spring | 5. Mud Spring | 6. River Geyser |

UPPER BASIN

Biscuit Basin

- | | | |
|-----------------------|------------------|------------------------|
| 1. Cauliflower Geyser | 2. Shell Geyser | 3. West Mustard Spring |
| 4. Avoca Spring | 5. Island Geyser | 6. Jewel Geyser |
| 7. North Geyser | 8. Rusty Geyser | 9. Silver Globe |

Cascade Group

- | | | |
|---------------------|-------------------|--------------------|
| 1. Artemisia Geyser | 2. Seismic Geyser | 3. Atomizer Geyser |
|---------------------|-------------------|--------------------|

Morning Glory Group

- | | | |
|--------------------------|--------------------|-------------------------|
| 1. East Sentinel Geyser | 2. Spiteful Geyser | 3. West Sentinel Geyser |
| 4. Fan and Mortar Geyser | | |

Chain Lake Group

1. Link Geyser

Grotto Group

- | | | |
|------------------|------------------------|---------------------|
| 1. Grotto Geyser | 2. Surprise Geyser | 3. Riverside Geyser |
| 4. Rocket Geyser | 5. So. Surprise Geyser | 6. Spa Geyser |

Giant Group

- | | |
|-----------------|------------------|
| 1. Bijou Geyser | 2. Oblong Geyser |
|-----------------|------------------|

Grand Group

- | | | |
|------------------|----------------|-----------------|
| 1. Grand Geyser | 2. Vent Geyser | 3. West Triplet |
| 4. Turban Geyser | 5. Rift Geyser | Geyser |

Castle and Sawmill Groups

- | | | |
|----------------------|-----------------------|-------------------|
| 1. Castle Geyser | 2. Spasmodic Geyser | 3. Spanker Geyser |
| 4. Tilt Geyser | 5. Tardy Geyser | 6. Sawmill Geyser |
| 7. Bulger Geyser | 8. Deleted Tardy | 9. Penta Geyser |
| 10. Sprinkler Geyser | 11. Deleted Teakettle | |

Black Sand Basin

- | | |
|-------------------|-----------------|
| 1. Spouter Geyser | 2. Cliff Geyser |
|-------------------|-----------------|

Daisy Group

- | | |
|-----------------|--------------------------------|
| 1. Comet Geyser | 2. White Pyramid Throne Geyser |
|-----------------|--------------------------------|

Myriad Group

Three Sisters:

- | | | |
|-----------------|-----------------|-----------------|
| 1. North Crater | 2. Round Geyser | 3. White Geyser |
|-----------------|-----------------|-----------------|

Giantess Group

- | | | |
|-------------------------|-------------------------|---------------------|
| 1. Little Squirt Geyser | 2. Little Cub | 3. Vault Geyser |
| 4. Anemone Geyser | 5. Lion Geyser | 6. Giantess Geyser |
| 7. Surge Geyser | 8. Goggle Spring | 9. Infant Geyser |
| 10. Plume Geyser | 11. North Goggle Spring | 12. Solitary Geyser |
| 13. Beehive Geyser | 14. Beach Spring | 15. Bench Geyser |
| 16. Depression Geyser | 17. Aurum Geyser | 18. Sponge Geyser |

Old Faithful Group

- | |
|-----------------|
| 1. Old Faithful |
|-----------------|

Lone Star Group

- | |
|--------------|
| 1. Lone Star |
|--------------|

In addition to the above named springs, 28 unnamed ones were observed in eruptive activity.

LOWER GEYSER BASIN

Great Fountain Group

Great Fountain: During the season Great Fountain erupted with a fair degree of regularity. It only went into one of its lapsing periods once during the season. During the last two days in May and the first two in June no normal eruptions occurred. Usually this type of behavior does not last for more than about two days. These periods of no activity, with the water receding 8 to 10 feet in the crater, have, during my observations, occurred more frequently in late fall and early winter than during any other period of the year.

As the season progressed the average time of Great Fountain's eruptions increased. This is made evident by the data on the following table. The reason for this increase is as much an enigma as are the lapsing periods in activity which occasionally occur.

During the season I observed several of the big eruptions for which it is famous. On August 8, after a slow start, and with the water receding in the crater, a mighty explosion occurred. With quick successive impulses the rocketing jets rose higher and higher. A near tidal wave rolled from off the terraces. The magnitude of the eruption was most impressive. I judged the height to be 200 feet plus. The embankment near the terraces to the south and east bore evidence of many power plays which were not observed.

Table Showing Great Fountain's Activity for the 1969 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	68	8 hr. 12 min.	9 hr. 0 min.	7 hr. 28 min.
July	67	8 hr. 30 min.	9 hr. 0 min.	7 hr. 42 min.
August	78	8 hr. 36 min.	12 hr. 40 min.	7 hr. 23 min.
September	49	9 hr. 05 min.	11 hr. 30 min.	7 hr. 48 min.

Two small geysers east of the road above Great Fountain were observed in frequent eruptive activity. There was evidence of infrequent geyser activity in two additional springs.

Surprise Pool functioned essentially the same as during 1968. At about hourly intervals the water would rise and overflow and then ebb about 6 inches in the crater.

During early August the bowl of Broken Egg Spring filled. Following the 1959 earthquake the water dropped about 10 inches in its crater, where it remained until the above mentioned time. Presently there is a slight overflow.

White Dome Geyser: None of the ninety and over minute intervals which are frequent some seasons were observed during the current one. The intervals ranged between about 15 and 30 minutes. Two small geysers west of White Dome were very active all season.

During the first half of the season Gemini Geyser erupted several times daily, the eruptions lasting about two minutes. During July an earthquake-caused crack in the sinter a few feet east of Gemini began erupting. By August its activity brought about complete cessation of activity of Gemini. The new geyser has been referred to as the Crack. The duration and height of its eruptions are essentially the same as Gemini. There is a noticeable sympathy between Crack and Pebble geysers. Action of the former always produces agitation and frequently eruptions of the latter.

Sometime during the winter of '68 and '69 a spring on the northeast side of Mushroom Spring's mound began steady eruptive activity. This resulted in an ebb and cooling in Mushroom. Currently its crater is filled with leather-like masses of algae.

Pink Cone Group

Pink Cone Geyser has been a very consistent performer since the '59 earthquake greatly shortened its interval. Eruptions occur about every six hours and last from about 90 to 105 minutes. During the activity the water column will momentarily subside in height to be followed by renewed vigor in activity.

Certain hot springs in the basins are recipients of greater misuse than others. Pink Cone seems to be one that vandals delight in abusing with their malpractices. Fortunately it has a constricted pipe and most of the rocks thrown into it are disgorged at the time of an eruption. Once during the season a large block of rock was placed so it completely covered the crater.

Narcissus and Bead geysers erupted with their usual regularity; Narcissus playing about every six hours and Bead's intervals varying from 27 to 30 minutes. Four unnamed geysers in the Pink Cone Group were observed in frequent eruptive activity.

Firehole Lake

The earthquake-caused geyser on the edge of Firehole Lake boiled steadily all season. Young Hopeful Geyser and four additional small vents near it, also squirted steadily throughout the season.

In the early part of July the energy in Steady Geyser shifted to the upper vent. For the remainder of the season a heavy volume of water steadily discharged to a height of from 8 to 10 feet. This is the greatest amount of activity since its cone was riven by the 1959 earthquake.

Fountain Group

Paint Pot: This famous spring is a near rival to Morning Glory for popularity. It is by all odds the spring in the Lower Basin which is of greatest interest to the park visitor. The mud in the crater, true to form, gradually ebbed as the season advanced. In September the temperature is 8 to 10 degrees F. hotter than in May and early June.

Red Spouter: In early June the water phase in this spring changed to the steam phase. It is continuing to enlarge its crater. The same is true of the new mud spring 20 feet to the south. Most of the time Red Spouter has ejected reddish colored mud, however, at times it has been gray.

Fountain Geyser: Sometime during the winter of '67 and '68 Fountain rejuvenated after a near 4 years of dormancy. This rejuvenation is still persisting.

Fountain has two types of eruptions; major and minor ones. During the early part of the season only minor eruptions were noted. During July there seemed to be alternation between major and minor activity. In the latter part of the season most of the eruptions were of a major character. Morning Geyser showed no activity during the season.

Clepsydra Geyser: The near steady action induced in this geyser by the '59 earthquake still persists. The only observed time there is cessation in its activity is following one of Fountain's major eruptions. Clepsydra's steam vent was less active than most seasons.

During the early part of the season both Jet and Spasm geysers had the appearance of dormancy. The first observed eruption of Jet was

On June 23. At about this time Spasm also rejuvenated. Other named geysers in this group which showed eruptive activity were Twig, Jelly and Sub. The earthquake-caused geysers (unnamed) northwest of Clepsydra showed frequent activity.

During the 68-69 winter two new springs developed in a spot which became hot ground following the 1959 earthquake.

There was no observed ebb in Silex Spring. Some seasons this ebb occurs frequently. Between the walk and Celestine Pool the runoff from Silex Spring received more than its quota of sticks and rocks during the season.

Hotel Group

There is a higher percentage of named springs in this group than any other group in the geyser basins. In fact, all of them are named. This is no doubt due, in part at least, to the fact that the Hayden Survey had its camp in the Lower Basin very near these springs.

Two of the springs in the Hotel Group are geysers: Thud and Kidney. Active cycles of Thud seem to be quite infrequent. It erupts 12 to 15 feet high. Kidney erupts several times each day, the activity being in the nature of vigorous boiling. While the Fountain Hotel was in operation all springs in the group were subject to a great amount of vandalism.

Kaleidoscope Group

Activity in this group seemed to follow essentially the same pattern as during 1968. Most of Kaleidoscope Geyser's eruptions were of short duration - 60 to 90 seconds. When this condition exists the intervals are from about 2 to 3 minutes. Nearby Blue and Honeycomb geysers erupted one or more times each day.

Several small geysers, some of them earthquake induced, erupted several times each day. There is no indication that Earthquake Geyser has been active since late 1959. Due to infrequent visitation there is little evidence of vandalism in this group.

Camp Group

Snort is the only known geyser in this group. It was observed in an active phase two times during the season. An eruption lasts for several hours.

Morning Mist Geyser in a group of that name, erupts one or more times each day. The eruption is in the nature of heavy boiling with near one second foot of discharge.

Porcupine Hill Geyser

One of the interesting developments this year is a new geyser on the east side of Porcupine Hill. Before the USGS drilling in 1968 there is no known record of any geyser activity in this particular spring. The drill hole (about 50 feet distant) no doubt permitted the necessary evolution of heat to bring about eruptive activity. The spring is superheated, being 203°F in temperature.

There does not seem to be any regularity to the eruptions. They have occurred as often as once a day, and over a week has passed without any activity. No eruption has as yet been observed, but the surrounding terrain is indicative of voluminous discharge with a short period of play. The water column would seem to angle to the west.

River Group

In June there was still cyclic activity in Ojo Caliente, but by the end of the season conditions seemed to have reverted back to what they were before the test hole was put down in 1968. About 100 feet northeast of the test hole new hot ground has developed.

The water in Skeleton Pool and the big pool west of it is still several inches below their preearthquake levels.

There are at least four active geysers in the River Group, only one of which is named - Mound. One eruption of Mound was observed. The water played up to a height of from 8 to 10 feet for about 5 minutes.

On the east side of Pocket Basin scores of new mud puffs developed following the 1959 earthquake. Most of the new puffs developed in groups. This has resulted in their coalescing, producing new paint pots.

MIDWAY GEYSER BASIN

Activity in this basin followed essentially the same pattern as during 1968. Excelsior without diminution or apparent change, still discharges its huge energy potential into the Firehole River. There is no question in the author's mind but that when it sufficiently licks its wounds which were incurred in the 1880's, more mighty explosions will issue from this "Hell's Half Acre" crater.

It has been several years since there was any observed eruptive activity in Opal Spring. The cause of its dormant cycles is unknown. The crater bears mute evidence of much geyser activity prior to historic records.

Named geysers which were observed to erupt include Tromp, East and West Flood, Catfish, Mud Spring and River Geyser. I know of but one active geyser in the Midway Basin that is unnamed.

The fact that East and West Flood have on infrequent occasions been observed to erupt simultaneously might be mere coincidence. Even though the river separates these geysers subterraneous connections are not unlikely. In fact, it is highly probable that their roots entwine.

UPPER GEYSER BASIN

Biscuit Basin

Hot spring activity in this basin seemed to undergo little alteration or change during the season. As in 1968, there was no evidence of activity in Black Pearl or Coral geysers. However, there were occasional puffs of steam from Coral. This kind of function has not been observed before. A vent in the same crater as Silver Globe has occasional eruptions from 10 to 12 feet in height. The duration is less than a minute.

The intervals on Jewel Geyser are from 6 to 8 minutes. During an eruption there are from 2 to 3 bursts. Rusty Geyser was very busy all season. The eruptions occurred every 1 to 2 minutes. Most of them were from 8 to 10 feet in height.

Avoca Spring continues to have minor and major eruptions. The intervals vary from 2 to 12 minutes. The major eruptions follow the long intervals and are from 10 to 12 feet in height. The duration is about 20 seconds. Eruptive activity of this spring was earthquake induced.

Cauliflower Geyser erupts at near hourly intervals. Overflow and boiling constitute an eruption. The two small geysers west of Cauliflower, which became active following the '59 quake continue to erupt.

Mirror Pool was the recipient of much park visitor rubble during the season. The small geysers west of Mirror, which are active some seasons, were dormant during 1969.

Sapphire Pool: During the 1968 season this lovely spring reverted back to essentially a preearthquake function, with brilliant sapphire color largely restored. During 1969, instead of eruptive activity occurring every 15 to 17 minutes, Sapphire has shown no true geyser activity. The boiling in the spring has been constant. Periodically there is increase in vigor of the boiling.

Cascade Group

Artemisia Geyser: This geyser might be considered the dominant one in Cascade Group. However, the newly developed Seismic Geyser outrivals it in some respects. Its eruptions are fully as high as Artemisia's and occur with much greater frequency.

Artemisia seems very staid in the nature of its behavior. Year after year it erupts on essentially the same pattern; the eruptions continue to occur at about the same frequency. It is one of nine springs in the Firehole Geyser Basins whose waters were not roiled by the 1959 earthquake. The road that was constructed by the edge of this geyser serves as an excellent vantage point for viewing this lovely spring during the quiet phase. But, from this angle the character of the eruption cannot be seen to advantage or appreciated.

Atomizer Geyser: Although Atomizer is situated on the same embankment as Artemisia, I have not as yet recognized any evidence that they might be connected subterraneously. During the season many eruptions of Atomizer were observed. The nature of these eruptions is described in the 1968 report.

Calthos Spring and Gem Pool are connected underground. During most seasons the overflow is from Gem. However, at times Gem will ebb with consequent overflow of Calthos. During the current season the overflow has come steadily from Gem. On rare occasions Calthos displays geyser activity. I have seen it erupt to a height of not less than 20 feet. It was quite active for a few weeks following the 1959 earthquake. During the current season a considerable amount of rubble has been thrown into Gem.

Seismic Geyser: In the long history of Yellowstone's geysers Seismic is one of the most recent to arrive on the scene. The manner of its origin, and other physical evidence, is highly suggestive that earthquakes have played an important role in the evolution of many of the geysers. There is a high degree of probability that even Old Faithful is of earthquake origin.

There seemed to be little change in the manner of Seismic's function during the current season when compared with 1968. The intervals ranged between about 40 and 50 minutes; the duration was about 15 minutes. Most of the bursts are from 10 to 15 feet in height, with an occasional one much higher. Some of the higher bursts come near the end of the active phase.

Due to Seismic's development the water in the two large springs to the east is still down about 10 feet in their craters. Hillside Geyser is also dormant, with the water down about 4 feet in both its craters. If, and when Hillside rejuvenates Seismic in all probability will become dormant.

A small cone type geyser on the edge of the river, about 200 feet below Hillside, is periodically erupting to a height of about 3 feet. This is the first season I have observed any geyser activity. Previously it has been a steadily boiling spring.

Morning Glory Group

Morning Glory continues to be a victim of considerable misuse by too many thoughtless park visitors. It is a first class trash receptacle. The higher level of the water in the pool, forming a moat about its border, should be an aid in helping to reduce vandalism. The moat gives Morning Glory a different appearance and color setting than has characterized it since discovery.

Fan and Mortar: During the 1969 season these geysers have shown a marked rejuvenation. There have been far more eruptions than during any season when I have been in the Upper Basin. From May through most of October 28 eruptions were known to have occurred. During May, due to inadequate coverage, some eruptions were most likely missed. There is no park record extant which is revealing of as great an amount of activity of these geysers as occurred this season. The prediscovery record Fan and Mortar have incised into older formations about their craters is revealing of a long period of eruptive activity; and on a scale greater than anything known in historic times.

It is believed that the rejuvenation of Spiteful Geyser in 1964 might have been a precursor to this season's activity of Fan and Mortar. Spiteful's activity since 1963 is indicative of increased thermal energy in the complex. Spiteful is situated along the same rift as Fan. This rift or break in an older sinter was in all probability caused by an earthquake, which resulted in the evolution of these geysers.

An eruption of Spiteful does not seem to initiate activity of Fan and Mortar. During all of the eruptions of these geysers Spiteful was dormant. With the first suggestion that an eruption of Fan is pending water starts jetting along the crack nearest the river to a height of from 6 to 8 feet. After a short period of this preliminary activity water suddenly lifts from all vents along the rift. The most powerful discharge comes from the vent nearest Spiteful. It cascades water out over the road. With the burst of activity in Fan there is simultaneous action in both vents of Mortar. The highest vent of Mortar momentarily shoots water to a height of about 60 feet and with marked abruptness it enters a steam phase.

The noise of an eruption, in connection with water jetting from not less than eleven vents, makes activity of these geysers something long to be remembered. Those who have seen an eruption in its entirety have described it as "incredible", "marvelous", "fantastic".

Two times during the season I saw water shoot up from 10 to 12 feet in Mortar's lower crater with no increased jetting of Fan. This might suggest that Mortar could erupt independently of Fan.

Until the Morning Glory Pool sign was removed from beside Spiteful there was a terrific amount of vandalism in the Fan and Mortar complex. Coming from Old Faithful for the first time many people mistook Spiteful Geyser for Morning Glory. There was resultant swarming over the formation and throwing of rocks into the vents. Action in Spiteful was mistaken for an eruption of Morning Glory.

Chain Lake Group

No major activity occurred in Link Geyser during the current season. However, minor eruptions occurred about every 3 to 4 hours. An eruption lasts about 13 minutes. The eruption is in the nature of heavy boiling, with the water surging up 3 to 4 feet. Culvert Geyser boiled steadily all season. No other springs in the group showed eruptive activity.

Grotto Group

Grotto Geyser: During the past few seasons Grotto has shown little or no variation in its eruptive pattern. It continues to play about half of the time. There is considerable variation in the length of the quiet and active phases.

During an eruption of Grotto there are one or more eruptions of Rocket. These eruptions last about 4 minutes, during which there is near cessation of activity in Grotto. No major eruptions were observed in Spa.

Grotto Fountain: This geyser is a part of the Grotto complex. When it erupts it is a certain precursor of an eruption of Grotto. Some seasons Grotto Fountain is very active. It is also known to have long periods of dormancy. It displayed little eruptive activity during the current season. But three eruptions were reported.

Riverside Geyser: During the season this geyser showed a high degree of regularity, as is shown in the following table. Most of the eruptions did not vary more than 10 to 15 minutes from the average time.

Table Showing Riverside's Activity for the 1969 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	105	6 hr. 18 min.	6 hr. 30 min.	5 hr. 51 min.
July	105	6 hr. 18 min.	6 hr. 30 min.	5 hr. 50 min.
August	108	6 hr. 12 min.	6 hr. 25 min.	5 hr. 51 min.
September	75	6 hr. 10 min.	6 hr. 35 min.	5 hr. 50 min.

Giant Group

Giant Geyser: Giant and its satellite springs showed little animation. Bijou's activity was of a feeble character. It was on very few occasions that I saw the water in Giant's crater rise above its outer rim. The south Purple Pool overflowed quite heavily all season. The Purple Pools ebb from 3 to 4 feet during an eruption of Giant.

Oblong Geyser: During the first part of the season this important geyser erupted on a pattern that has characterized it since records were first kept. There were about two years following the 1959 earthquake when its intervals were shortened from the near 6 to 8 hour historic range to about 4 to 6 hours. During the past few years the intervals have occurred on the old time pattern - between about 6 and 8 hours.

In early August it became apparent to all observers that Oblong was seldom seen in an eruption. The last eruption checked in August was on the 15th. Following this date there is no record of further activity until September 8. During most of the period between August 15 and September 8 I had markers which were indicative that no eruption took place. During September an eruption was noted on the 23rd and again the 30th. Since the 30th, to the time of this writing, no further activity has been observed.

An eruption of Oblong is not easily missed if there is occasional coursing in the Basin. While an eruption lasts for but near 7 minutes, it takes the big and exquisitely decorated crater from 3 to 4 hours to fill. At the time of an eruption the heavy discharge of water and consequent evolution of steam results in many seasoned observers when near Old Faithful to mistake it for an eruption of Grand Geyser.

There is no record of Oblong ever having been as irregular and infrequent in activity as has characterized it the latter part of the 1969 season. The cause of this very unusual behavior is presently unknown. It may be mere coincidence that the disruption of the eruptive pattern occurred a few weeks following the discharge of the new spring which resulted from road construction on the old Black Sand Road. However, it is the author's opinion, based on long observation of hot spring behavior, that the heavy draft of water by this man-made spring will eventually result in abnormal behavior of additional hot springs in the Upper Basin than those presently known to have been changed in their function.

That springs near the new development are already being affected by the new discharge is evident from the drying up of a spring about 100 yards to the north and lowering of the level of springs still farther to the north; also the dwindling in output of a spring of former steady high discharge, which is located on the edge of glacial outwash, about 100 yards southwest of the overpass piling. This latter spring, prior to the man-made spring, had a steady discharge of about 200 gallons per minute. By early August the discharge had dwindled to about 25 gallons per minute. By mid-October not more than 2 gallons per minute were flowing. Further, there has been a measurable lessening of discharge of the man-made spring during the above period. A logical conclusion is that the heavy draft of this spring is lowering the water table, thereby reducing hydrostatic pressure. In due time other effects than the above are probable.

Daisy Group

It is difficult to imagine a group of springs, such as Daisy, having become so prosaic in so short a time. Prior to the 1959 earthquake this group was second only to Old Faithful as a geyser attraction. The resulting dormancy of Daisy and Splendid, due to the 1959 incident, reduces the group to one of slight interest to the average park visitor. It holds but academic interest to the scientist. Little did I expect to see the change in this group that has occurred during the relatively short period of my observation. A major earthquake has proven itself to be a potent factor in bringing about abrupt changes in hot spring behavior.

On August 10 an eruption of Daisy was reported. I was not in the Basin at the time, but attendant circumstances are suggestive that the eruption was not of natural occurrence. At no time during the season did ebbing of Bonita take place, as was the case during the 1967-68 seasons.

Round Spring Group

Round Spring for the most part overflowed steadily all season. There were a few brief periods when the water ebbed about 6 inches. The water was down about a foot in North Round Spring all season.

During the current season both of the above springs were victims of considerable vandalism. A great quantity of rubble was thrown into their craters.

During most of the season Round Spring Geyser was dormant. Activity was observed only in late August and early September.

Black Sand Basin

For the greater part of the season this basin was largely out of bounds due to new road construction. Occasional observations were revealing that no major changes had taken place. Some of the green hues which were responsible for the naming of Emerald Pool seemed more in evidence than during previous seasons since the earthquake. There was no evidence that Green Spring had shown any geyser activity, which is characteristic some seasons. Cliff and Spouter geysers were both observed in eruptions. The algal mat about Sunset Lake has grown to a degree that some of its drainage is diverted into Rainbow Pool. Apparently this latter pool overflowed all season.

Myriad Group

Three Sisters: The current season is the first one since the 1959 earthquake that these springs have completely filled with resultant overflow. There was no eruptive activity in the north Sister during the 1968 season, however, during the present one the east vent in this crater has erupted about every 8 to 10 minutes, the action lasting for about 1 minute. There was no evidence of eruptive activity in the middle Sister. Little Brother was dormant.

The rest of the springs on the Myriad Group functioned on about the same pattern as during the 1968 season. Round Geyser with abrupt suddenness would occasionally shoot a powerful jet of water to a height of from 40 to 50 feet. The eruption lasts for but a minute or less. As closely as could be determined the intervals varied between about 10 and 14 hours. Myriad Geyser is still dormant. There has been no observed activity since 1953. White Geyser was very active, erupting about every 1 to 2 minutes.

Seasonally a great deal of vandalism takes place in the Myriad Group. The evidence seems quite conclusive that it is mostly perpetrated by Old Faithful Inn employees. Other Yellowstone Park Company employees are no doubt involved.

Castle and Sawmill Groups

There are relatively few springs in the Castle Group. There are five active geysers, all of which performed on about the same patterns as during 1968. Spanker is a steady geyser. The spring on the edge of the road across from Castle, daily, was the recipient of numerous handfuls of pebbles, sand and rocks from the road shoulder. At the rate debris is being thrown into this spring its eventual filling would seem to be only a matter of time.

Castle Geyser: The average interval on Castle for the season was slightly shorter than during 1968. Non-steam-phase eruptions occurred about once weekly. These 2 to 4 minute eruptions delay the steam-phase ones about 4 hours. The length of the delay seems to be governed by the duration of the period of short activity.

Table Showing Castle's Activity for the 1969 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	61	8 hr. 31 min.	10 hr. 25 min.	7 hr. 0 min.
July	71	8 hr. 42 min.	9 hr. 18 min.	8 hr. 15 min.
August	70	8 hr. 36 min.	9 hr. 32 min.	8 hr. 15 min.
September	50	8 hr. 42 min.	9 hr. 28 min.	8 hr. 18 min.

In giving the maximum and minimum intervals only steam-phase eruptions are considered

There was about one degree of super-heat in Crested Pool all season. No activity that might be referred to a geyser in character was observed. However, every few minutes there would be evidence of increased convection and evolution of heat.

Like Morning Glory, Crested Pool has developed a marked moat about its border. This deep steep-walled pool contains an untold amount of human introduced trash. A major eruption would no doubt do much in disgorging extraneous matter.

Sawmill Geyser: As during the early part of the 1968 season no activity was observed in Sawmill until mid-season. During the latter part of the season eruptions occurred daily. The duration of the activity is from about 90 to 105 minutes. Tardy Geyser is usually dormant during an eruption of Sawmill. Infrequently these geysers will play in concert. When they do the activity of Tardy is much more vigorous. The long periods of activity of Tardy appear to be the cause of the long dormant periods of Sawmill.

Other geysers in this group that were observed to erupt include Deleted Teakettle, Deleted Tardy, Bulger, Spasmodic and Penta. Two unnamed springs showed eruptive activity.

Grand Group

During the season Grand played with a fair degree of regularity. The majority of the eruptions were predictable within a two hours range. The 1969 average length of interval was about one hour shorter than during 1968.

On June 2nd Grand was observed erupting on a different pattern from anything previously recorded since it was first observed by the Hayden Survey in 1871. During the years I have observed Grand the average eruption has lasted from 15 to 17 minutes, during which there were from 7 to 13 bursts. Some seasons the average number of bursts would vary two or more than during other seasons. There have been short periods when as many as 15 to 17 bursts would be recorded. On one occasion in 1947 I observed an eruption that lasted for an hour and a half, during which there were 44 major bursts.

On June 2nd an eruption was observed that had but two bursts. The first one lasted for 11 minutes and was characterized by continuous jetting of water from 75 to 100 feet in height. After a brief pause a major burst occurred, terminating the eruption.

The above pattern of activity continued for the remainder of the season. During the first 10 days following June 2 a number of 2 burst eruptions were observed. Since mid-June the number of bursts has varied between 3 and 5, with the first burst lasting from 8 to 10 minutes. This variation in Grand's eruptive pattern has not seemed to affect its degree of regularity. It might in part account for the shorter average over that of 1968.

Table Showing Grand's Activity for the 1969 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	68	9 hr. 51 min.	15 hr. 08 min.	8 hr. 22 min.
July	74	9 hr. 51 min.	12 hr. 30 min.	8 hr. 41 min.
August	73	9 hr. 50 min.	12 hr. 20 min.	7 hr. 04 min.
September	49	9 hr. 05 min.	11 hr. 30 min.	7 hr. 48 min.

The normal sequence of activity of Turban and Vent which follows an eruption of Grand did not in any way seem to be altered by Grand's changed pattern.

Geyser Hill

There is perhaps a greater concentration of eruptive springs on Geyser Hill than is found in any similar area or grouping. They range from some of the smallest to two of the largest in the Park. During the period I have observed the springs on Geyser Hill I have seen eruptive activity in 41 of them.

Many of the smaller named geysers, which include Little Squirt, Anemone, Depression, Bench, Roof, Beach, and Sponge, were quite active during the season. Activity in Bench and Little Squirt was cyclic. There would be comparatively long periods of activity followed by equally long dormant periods. Surge Geyser was not observed to erupt. Several eruptions were noted in North Goggle. Prior to the '59 earthquake this spring was not known to be a geyser. No further eruptive activity was observed in the springs at the base of Sponge. Two springs at this site had eruptions during 1968 of sufficient violence to enlarge their craters. During the latter part of the season a small geyser located between Infant and Dome was quite active. Roof Geyser continues to erupt at about 5 minute intervals.

Plume Geyser: Of the geysers of sufficient magnitude to attract by their size, Plume was by far the most active of any on Geyser Hill. During the season, as in recent years, it continued to play with marked regularity. The observed interval range was between 27 and 30 minutes. The majority of the intervals were either 28 or 29 minutes.

Lion Geyser: During the first part of the season Lion showed a marked rejuvenation. It went into an active phase more frequently than during any season since 1958. During the latter part of the season the activity tapered off, the active phases occurring about once each week, which has largely been its habit since 1958.

Giantess Geyser: Giantess erupted more times during the current season than any previous one since 1947. It went into an active phase on June 28, July 12 and 28, August 12, and September 15. No eruptions occurred during May and October. The June and August eruptions were of the steam-phase type, as was the case with the July 28 eruption.

The June 28 eruption did not last for more than 12 hours. The same was true for the July 28 and August 12 eruptions. While the water-phase type, which occurred on July 12 and September 15, lasted near 36 hours. All eruptions except the July 28 one, which began at 8:25 a.m., started during the pre-dawn hours.

Beehive Geyser: While this important geyser was not as active as during the 1968 season, the number of eruptions recorded far exceed its habit for most of the seasons I have been in the Old Faithful area.

The known number of eruptions occurring each month are as follows:
 May - 6, June - 6, July - 5, August - 2, September - 9, October - 8,
 making a total of 36 eruptions. During the 1968 season 77 eruptions
 were recorded.

Some of Beehive's eruptions were preceded by the indicator; others
 were not. The indicator performed a number of times without a
 consequent eruption of Beehive.

Old Faithful:

Table Showing Old Faithful's Activity for the 1969 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	218	65.4 min.	87 min.	38 min.
June	299	66.7 min.	96 min.	38 min.
July	338	65.7 min.	93 min.	39 min.
August	340	65.6 min.	93 min.	38 min.
September	256	64.7 min.	93 min.	38 min.
October	242	65.1 min.	94 min.	40 min.
Season	1693	65.5 min.	96 min.	38 min.

1970

Hot Spring Activity In The Geyser Basins Of The
Firehole River for the 1970 Season

George D. Marler

Geyser activity was known to occur in the following hot springs
during 1970:

LOWER BASIN

Great Fountain Group

1. Great Fountain Geyser

Pink Cone Group

- | | | |
|----------------------|---------------------|-----------------|
| 1. Pink Cone Geyser | 2. Narcissus Geyser | 3. Bead Geyser |
| 4. White Dome Geyser | 5. Pebble Geyser | 6. Crack Geyser |

Firehole Lake

1. Steady Geyser
2. Young Hopeful Geyser

Fountain Group

- | | | |
|-----------------|----------------|------------------|
| 1. Clepsydra | 2. Sub Geyser | 3. Bellefontaine |
| 4. Jelly Geyser | 5. Red Spouter | 6. Twig Geyser |
| 7. Jet Geyser | 8. Fountain | 9. Spasm |

Hotel Group

1. Kidney Geyser

Kaleidoscope Group

- | | | |
|------------------------------|---------------------|---------------------|
| 1. Kaleidoscope Geyser | 2. Deep Blue Geyser | 3. Honeycomb Geyser |
| 4. Kaleidoscope Drain Geyser | | |

Morning Mist Group

1. Morning Mist Geyser

Camp Group

- | | |
|----------|--------------------------|
| 1. Snort | 2. Porcupine Hill Geyser |
|----------|--------------------------|

River Group

- | |
|----------|
| 1. Mound |
|----------|

MIDWAY BASIN

- | | | |
|-------------------|----------------------|----------------------|
| 1. Catfish Geyser | 2. East Flood Geyser | 3. West Flood Geyser |
| 4. Tromp Spring | 5. Mud Spring | 6. River Geyser |

UPPER BASIN

Biscuit Basin

- | | | |
|-----------------------|------------------|------------------------|
| 1. Cauliflower Geyser | 2. Shell Geyser | 3. West Mustard Spring |
| 4. Avoca Spring | 5. Island Geyser | 6. Jewel Geyser |
| 7. North Geyser | 8. Rusty Geyser | 9. Silver Globe |

Cascade Group

- | | | |
|---------------------|-------------------|--------------------|
| 1. Artemisia Geyser | 2. Seismic Geyser | 3. Atomizer Geyser |
|---------------------|-------------------|--------------------|

Morning Glory Group

- | | | |
|---------------------------|--------------------|-------------------------|
| 1. East Sentinel Geyser | 2. Spiteful Geyser | 3. West Sentinel Geyser |
| 4. Fan and Mortar Geysers | | |

Chain Lake Group

- | |
|----------------|
| 1. Link Geyser |
|----------------|

Grotto Group

- | | | |
|------------------|------------------------|---------------------|
| 1. Grotto Geyser | 2. Grotto Fountain | 3. Riverside Geyser |
| 4. Rocket Geyser | 5. So. Grotto Fountain | 6. Spa Geyser |

Giant Group

- | | | |
|-----------------|------------------|---------------|
| 1. Bijou Geyser | 2. Oblong Geyser | 3. New Geyser |
|-----------------|------------------|---------------|

Grand Group

- | | | |
|------------------|----------------|-----------------|
| 1. Grand Geyser | 2. Vent Geyser | 3. West Triplet |
| 4. Turban Geyser | 5. Rift Geyser | Geyser |

Castle and Sawmill Groups

- | | | |
|----------------------|-----------------------|-------------------|
| 1. Castle Geyser | 2. Spasmodic Geyser | 3. Spanker Geyser |
| 4. Crested Pool | 5. Tardy Geyser | 6. Sawmill Geyser |
| 7. Bulger Geyser | 8. Deleted Tardy | 9. Penta Geyser |
| 10. Sprinkler Geyser | 11. Deleted Teakettle | |

Black Sand Basin

1. Spouter Geyser

Daisy Group

- | | |
|-----------------|----------------|
| 1. Comet Geyser | 2. Bank Geyser |
|-----------------|----------------|

Myriad Group

Three Sisters:

- | | | |
|-----------------|-----------------|-----------------|
| 1. North Crater | 2. Round Geyser | 3. White Geyser |
|-----------------|-----------------|-----------------|

Giantess Group

- | | | |
|-------------------------|-------------------------|---------------------|
| 1. Little Squirt Geyser | 2. Little Cub | 3. Vault Geyser |
| 4. Anemone Geyser | 5. Lion Geyser | 6. Giantess Geyser |
| 7. Roof Geyser | 8. Goggle Spring | 9. Infant Geyser |
| 10. Plume Geyser | 11. North Goggle Spring | 12. Solitary Geyser |
| 13. Beehive Geyser | 14. Beach Spring | 15. Pump Geyser |
| 16. Depression Geyser | 17. Aurum Geyser | 18. Sponge Geyser |
| 19. Dome Geyser | | |

Old Faithful Group

1. Old Faithful

Lone Star Group

1. Lone Star

In addition to the above named springs, 32 unnamed ones were observed in eruptive activity.

LOWER GEYSER BASIN

Camp Group

Porcupine Hill Geyser: This geyser was first known to erupt during the 1969 season. A drill hole about 50 feet to the south, which was made by the USGS in 1968, apparently resulted in sufficient evolution of heat to bring about eruptive activity. During 1969 it erupted one or more times each week, however, no eruptions were observed.

During May of the current year I was fortunate enough to approach this geyser just as it started to erupt. The action was impressive. A heavy column of water played at an angle of about 45 degrees in a westerly direction. I estimated the height to be between 25 and 30 feet. The eruption was short, lasting between 20 and 30 seconds.

Since July Porcupine Hill Geyser has erupted infrequently. Its temperature has dropped from 203 to 200 degrees F.

During the season but one eruption of Snort Geyser was observed. An eruption lasts for several hours. It is located at the base of consolidated glacial till.

River Group

The eruptive activity communicated to Ojo Caliente due to near-by drilling in 1968 has completely subsided. The boiling has become steady.

The water level in Skeleton Pool and the big pool 100 feet to the west continues to remain several inches below pre-earthquake levels.

Mound is the only named geyser in the River Group. It erupts to a height of 8 to 10 feet; the eruption lasting about 5 minutes. On the opposite side of the river from Mound, and to the north, there are three small geysers, but their periods have not been determined.

The new mud pots on the east side of Pocket Basin show little change from their 1969 state. Apparently they are becoming stabilized.

Hotel Group

Only two of the springs in this group, Kidney and Thud, are known to be geysers. Since the 1959 earthquake no eruption of Thud has been witnessed. Kidney erupts several times each day. The activity is merely a vigorous boiling and overflow.

Kaleidoscope Group

Of the larger geysers in this group Kaleidoscope is the most active. The average interval varies between 5 and 7 minutes; the eruption lasting about 2 minutes. None of the short periods of activity which were observed in 1969 have been noted during the current season.

About mid-June Kaleidoscope became dormant. The energy shifted to Kaleidoscope Drain which is situated about 30 feet north of Kaleidoscope, most of whose erupted water flows into the Drain; hence the name. Kaleidoscope rejuvenated July 30, rendering Drain dormant. During Drain's period of activity the eruptions were frequent; about every 3 to 5 minutes. The height of most of the eruptions is from 10 to 12 feet. During some eruptions there will be a burst between 40 and 50 feet in height. In the early 1940s there was a period when Drain was active for over 2½ years with a dormant Kaleidoscope.

Deep Blue and Honecomb Geysers which are situated near Kaleidoscope erupted less frequently than during 1969. Some seasons they are much more active than during others. Four small geysers lying east of Kaleidoscope erupted frequently. Their present active cycle was stimulated by the 1959 earthquake.

Gentian Pool continues to be one of the most beautiful and awesome of any in the park. Warning signs such as are at Skeleton Pool should also flank Gentian, and all other springs with shelving ledges in the interest of safety.

Fountain Group

Paint Pot: This interesting spring continues to be one of the major hydrothermal attractions in the park. changes which might have taken place in it since discovery have been minor. Following the 1959 earthquake there was greatly increased activity. New mud pots were formed. However, at present it is in very much the same state as prior to the 1959 incident.

By the end of August of the current season the mud in the active south end had ebbed about 15 inches below its June level. This ebb was in part due to several weeks of scanty precipitation, but more in particular to the lowering of the ground-water table. Interestingly, near the end of September the muddy mixture begins to rise and becomes less viscous.

Red Spouter: It was near the first of July when this earthquake-creation changed from its liquid to steam-phase function. Near the beginning of each October the pattern is reversed. Each season since 1959 the crater has been increasing in size. It causes speculation to the effect that some day it might coalesce with the Fountain Paint Pot.

Fountain Geyser: In the Fountain Group this geyser was not much behind Clepsydra in furnishing a first class hydrothermal spectacle for park visitors. During an eruption, which sometimes lasts for an hour, the water surges from the crater in a somewhat rotary motion. Most of the surges are 10 to 15 feet, with droplets occasionally being jetted near 40 feet. As closely as I could determine eruptions occurred about every 4 to 5 hours.

Following an eruption the water drops 4 to 5 feet in the crater. There is a corresponding drop in Morning Geyser. When Fountain fills high enough so water can flow into Morning, Morning slowly rises and overflows during Fountain's activity. Morning was dormant all season.

Clepsydra Geyser: The near-steady eruption of Clepsydra characterized it all season. The only time brief interludes of quiescence were observed was following an eruption of Fountain. The steam vent, which gives an awesome character to Clepsydra was active most of the season. This was not the case during 1969.

Other named geysers in the Fountain Group which were active during the season were Twig, Jet, Spasm, Jelly, Bellefontaine, plus 3 small unnamed geysers.

Three times during the season the water ebbed 3 to 4 feet in Silex Spring, making possible the removal of a considerable amount of trash.

Firehole Lake

From the visitor's viewpoint Steady Geyser seemed to be the major attraction at Firehole Lake. Its steady action and voluminous

discharge draw immediate attention. Much the greater part of the water in Tangled Creek must come from this spring. The upper vent was the only one active during the season. Activity in the upper vent started in July 1969.

Due to the development of numerous small squirters, all within a few feet of where Young Hopeful is supposed to be, it is uncertain which was the original Young Hopeful. Over an area of about 8 feet square there are not less than 22 small vents, all jetting water. These vents could coalesce, forming a major unit. If the name Young Hopeful were given to this small geyser with the thought it might grow up, the near 100 years of its known existence still finds its hope unrewarded.

Pink Cone Group

Pink Cone Geyser continues to erupt with about the same frequency that was communicated to it by the 1959 earthquake. Eruptions occur about every 6 hours and last for about one and three-quarter hours. During most of an eruption there is waxing and waning in the intensity with which the water is ejected. During the concluding stages action will momentarily cease followed by a renewal of activity.

Four unnamed springs in the Pink Cone Group erupt frequently. Their periods have not been determined. All are small, two erupting to a height of about 6 feet. Narcissus and Bead Geysers erupted on essentially the same patterns as in 1969.

White Dome Geyser: White Dome seemed to be more erratic than during the 1969 season. Some days the intervals were short, being between 15 and 20 minutes. On other days some intervals were well over an hour in length. One man reported waiting an hour and 25 minutes to see an eruption. Why this geyser is so variable in its eruptive pattern has not been determined.

Both Crack and Pebble Geysers were very active all season, however, I saw no evidence of an eruption of Gemini. Apparently the thermal energy has shifted from Gemini to Crack.

When Pebble Geyser began erupting in 1968 the water gouged the shoulder of the road. The road crew inadvertently banked the shoulder with a load of gravel. To date a goodly portion of this gravel has found its way into the springs and over the formations. The urge to throw rocks is already too strong without the Park Service furnishing ammunition to the delinquent.

Great Fountain Group

Great Fountain: During much the greater part of the season this important geyser erupted with a fair degree of regularity. The eruptions occurred at near 8 hour intervals. However, from day to day there was steady progression of time on the near 8 hour periods.

Two times during the season Great Fountain had lapsing periods when no eruptions occurred. The one on June 3 was not more than a day in duration. The water stood about 8 to 9 feet below the rim of the crater. Sometime during the night of the 3rd conditions returned to normal. From August 8th through the 11th it went into one of those inactive states which characterize it one or more times during some seasons. During the 8th and 9th, splashing occurred about every 15 minutes. On the 10th all activity ceased and the water was down 8 to 9 feet in the crater. During the afternoon of the 11th and on into the night there was steady overflow, but no eruption. It erupted at 7:45 a.m. on the 12th. For the remainder of the season the intervals varied between about seven and one-half and nine hours. The cause of the occasional lapses or digressions remains an enigma.

Table Showing Great Fountain's Activity for the 1970 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	39	8 hr. 32 min.	9 hr. 0 min.	6 hr. 57 min.
July	68	8 hr. 30 min.	12 hr. 5 min.	7 hr. 23 min.
August	62	8 hr. 2 min.	9 hr. 10 min.	7 hr. 8 min.

In giving average time for August the four days of disturbance are not taken into account.

At about hourly intervals Surprise Pool would fill and overflow. Following the overflow it would ebb about 6 inches. Prior to the earthquake the level of this spring was constant.

Two small, unnamed geysers across the road from Surprise were very active. The pattern of their activity has not been determined.

There was steady overflow all season from Firehole Pool and Broken Egg Spring. The parking area, plus the retaining wall at Firehole Pool have created a somewhat hazardous situation. A heavy railing needs to be placed here.

MIDWAY BASIN

In the Excelsior area of Midway Basin all springs stayed in essentially the same state all season. It is unfortunate so many cars wheel by this area. In Excelsior and Grand Prismatic are found the two largest springs in the Park. It is certain that the great majority of those who take the trek over the hill feel well rewarded for their effort. Perhaps better roadside advertising would make more people aware of the beauty of the area.

The geysers in Midway Basin which were observed erupting include Tromp, River, Mud Spring, Catfish, Flood and West Flood. considerable data were obtained on the two Floods. It was determined that Flood has a series of eruptions occurring every 3 to 12 minutes and lasting from less than a minute to three minutes. These frequent eruptions, which increase in duration, lead up to the main eruption which lasts from 21 to 17 minutes. Following the short periods of activity the water drops about 15 to 22 inches in the crater, but following the long periods of play the drop is about 7 feet. Intervals checked following the main eruption were from 100 to 105 minutes.

Many intervals were determined for West Flood. They varied between 53 and 75 minutes. The duration of the activity has been from 5 to 12 minutes. Most of the eruptions last about 6 minutes. There seems to be a correlation between the length of an eruption and the length of the interval. Both geysers erupt with about equal vigor, closely resembling each other. I have observed no evidence that the two Floods might have subterraneous connections.

UPPER BASIN

Biscuit Basin

The great amount of thermal energy which was communicated to Biscuit Basin by the 1959 earthquake has not only been completely dissipated, but present manifestations of thermal energy are less than before the big tremor.

The earthquake brought about greater changes in Sapphire than any other spring in Biscuit Basin. Presently about all semblance of geyser activity has disappeared. Boiling in the crater is constant, however, at about 12 minute periods the boiling increases in vigor and the overflow is much heavier. Following the major boiling there is a drop of from 3 to 4 inches in water level.

Intervals on Jewel Geyser have varied between 6 and 9 minutes. There are from 2 to 3 jets during an eruption. Shell Geyser has been in a state of ebullition whenever observed during the season. However, occasionally the boiling greatly increases in vigor with resultant overflow. A spring 25 feet to the east of Silver Globe, and under the same ledge, erupts about every 20 minutes. The eruptions last for about 10 seconds. A small jet is shot out to a height of from 10 to 12 feet, at an angle of about 45 degrees.

Avoca Spring is about 30 feet north of Silver Globe. It is a very changed spring since the earthquake, having been converted into a geyser. Like Flood Geyser it has a series of minor eruptions which are from 3 to 6 feet in height to be followed by a major one which erupts to a height of about 15 feet. The intervals on the minor eruptions are from seconds to about 3 minutes. Following a major display the interval is from 13 to 15 minutes.

The water is still down about 5 feet in both West and East Mustard Springs. There is constant boiling of water. However, the jets do not rise above the rims of the craters. The boiling in West Mustard is with greater volume and vigor than in East Mustard.

Coral and Black Pearl Geysers have been dormant all season. There has been steady action in Island Geyser. Rusty Geyser erupts about every 1 to 2 minutes. An eruption lasts for less than half a minute. Some eruptions show greater vigor, the height being 6 to 8 feet.

Cascade Group

On the east side of the river there are 3 active geysers in this group, including Seismic, Artemisia and Atomizer. All are important geysers.

Seismic Geyser: Presently Seismic is the newest of the geysers in the Park which might be considered as being large. Prior to the earthquake its crater was the site of thrifty growing Lodgepole Pines.

During the past three seasons its action would seem to have become more or less stabilized. The sequence of its eruptions is somewhat difficult to determine due to several separate eruptions occurring during an active phase. During the times I have observed it this season the active and quiet phases have been about equal in length.

During an eruption, which lasts between 20 and 30 minutes, there are usually three separate periods of activity, during which there will be as many as 30 separate bursts of water. The highest bursts I have observed have come near the end of an eruption. Some were judged to approximate 40 feet. Checked intervals have varied between 20 and 30 minutes. Following an eruption the water drops about 14 inches in the crater.

The water is still down about 4 feet in Hillside Geyser and about 10 feet in two large springs on the bench to the east. Apparently Seismic is connected underground with the above mentioned springs.

Atomizer Geyser: This geyser was observed erupting many times during the season. Like a number of other geysers there are a series of eruptions which lead up to the main one. The eruptions which come in advance of the main one occur about hourly. They are of about a minute's duration. The main eruption lasts for 10 minutes and is more powerful. There is a concluding steam phase, which is not the case with a minor eruption. At the time of the main eruption, and only then, there is a steam phase in the cone situated by Atomizer.

Artemisia Geyser: During the season 121 eruption intervals were determined. As a result of systematic observation the behavior pattern of Artemisia is better understood than at any time previously.

The eruptions occur about two times during a 24 hour period. The shortest interval determined was 9 hours and 5 minutes; the longest slightly in excess of 15 hours. The great majority of the intervals ranged between about 10 and 12 hours. For the 121 checked intervals the average time was 11 hours and 46 minutes.

I have been able to observe no surface manifestation which might serve as an indicator of the time of an eruption. Following an eruption the water drops about 22 inches in the crater. Refilling takes place slowly, requiring from 4 to 5 hours for the water to reach the overflow stage. The overflow is steady, and with no apparent change in volume, until within about one minute of an eruption. The first indication of an eruption is an abrupt rise of about one inch in water level, resulting in very heavy overflow. Steam detonations at depth can be heard and felt. Almost immediately boiling starts in the crater, the violence of which gradually increases. It takes 2 to 4 minutes for the bursts to attain any size. The water spout is massive, the maximum height being about 25 feet.

The duration of an eruption is quite variable. The longest eruption checked was 36.5 minutes; the shortest 18 minutes. The great majority of the eruptions last about 21 to 23 minutes.

Morning Glory Group

Morning Glory Pool: This spring continues to be a first class trash receptacle. The moat about the border, plus a drop in temperature sufficient to permit growth of algae, has resulted in a vastly different appearing Morning Glory than earlier characterized it. The former blue has given way to shades of yellow, brown and red.

Fan and Mortar Geysers: The rejuvenation which characterized these interesting geysers in 1969 has persisted during the current season. By means of markers I have been able to determine the exact number of eruptions which occurred. Between May 1 and September 18 there were 24; three in May, two in June, seven in July, seven in August, and five in September. This compares with 28 eruptions during the same period in 1969.

Spiteful Geyser: Most of Spiteful's intervals ranged between about 20 and 25 minutes. Due to its nearness to Morning Glory it was a much photographed geyser. The eruption lasts for about 2 minutes. The height is 10 to 12 feet. Following eruptions of Fan and Mortar, Spiteful skips several eruptions, indicating underground connections with the former. Spiteful is situated along the same rift as Fan.

Chain Lake Group

Link was the only active geyser in this group during the 1970 season. Its eruptions last 12 to 15 minutes and occur about every 4 hours. Considerable water is discharged during an eruption. Some seasons Link will have major eruptions. The spring on the north end of Chain Lake will some years have powerful eruptions. None have occurred for several years.

Riverside Geyser:

Riverside's pattern was very much the same as in 1969. During these seasons it has erupted with greater frequency than during any previous time on record.

Table Showing Riverside's Summer Activity - 1970

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	94	6 hr. 12 min.	6 hr. 28 min.	6 hr. 0 min.
July	82	6 hr. 18 min.	6 hr. 37 min.	5 hr. 57 min.
August	103	6 hr. 8 min.	6 hr. 29 min.	5 hr. 58 min.

Grotto and Rocket Geysers: No difference in eruptive pattern was observed during the season. Grotto continues to be in an active phase about half of the time. There is quite a variation in the length of the active and quiet phases. An eruption of short duration is always followed by a short interval. One or more times during an eruption of Grotto there will be a 3 to 4 minute pause in its activity, during which all the energy seems to shift to Rocket, which erupts spectacularly.

Grotto Fountain: As during 1969, this geyser was relatively inactive this season. I saw but 3 eruptions. Three additional ones were reported. An eruption is a certain precursor to an eruption of Grotto, which usually starts about 2 to 5 minutes after the Fountain. Grotto Fountain is known to have had long periods of dormancy. Spa Geyser, which is a part of the Grotto Complex, has had no known major eruptions during the past two seasons.

Giant Group

Giant and other geysers occupying the same platform remained in essentially the same state as during 1969. They displayed but very little animation. It was only occasionally that water was observed to splash high enough in Giant so as to be visible from the road. There was feeble splashing from Bijou during most of the season.

Giant Geyser is known to be connected underground with the Purple Pools on the opposite side of the river. When I first observed these pools on May 1 I noted that a small geyser about 20 feet south of the south Purple Pool was erupting steadily. For about a week near the end of May when snow water from the hill was pouring into the crater it was quiescent. From June, through the rest of the season it was active about every 2 to 4 minutes;

the duration being about one minute. Some splashes attained a height of about 20 feet. Only on two previous occasions, and then for short periods, have I observed any activity in this geyser. A short distance to the south, and apparently on the same fissure, three new murky springs have developed, killing nearby trees.

Another new development in this area was a small geyser about 100 feet southwest of south Purple Pool. It was first observed September 1. It had broken through the sinter cover forming an aperture of about 4 by 5 inches. When in action the jet resembles Atomizer Geyser. Like Pink Cone the action will subside then increase in vigor. During the early stages of an eruption the water is jetted about 20 feet. No intervals have as yet been determined.

Oblong Geyser: Since early August 1969 eruptions of Oblong have been observed but infrequently. Prior to the above date records indicate a fair degree of regularity and frequency. The cause or causes of its greatly diminished activity have not as yet been determined.

Daisy Group

Bonita Pool continues to hold command in this group. Its steady overflow has resulted in complete dormancy of Daisy and Splendid Geysers. Occasionally the water will rise high enough in Daisy so that there is slight overflow to the south. Most of the time the water is below the rim of the crater. Comet shows enervated geyser activity.

Round Spring and Orange Group

Several times during the season the water would ebb from 8 to 10 inches in Round Spring. The ebb would persist for about a day before the crater refilled and overflow began. A small unnamed geyser in the Round Spring Group erupted steadily during May and early June, but was dormant the rest of the season.

The two geysers near the road in Orange Spring Group were dormant all season. Some years these geysers are very active.

Black Sand Basin

Sometime during the winter there was a shift of thermal energy from Rainbow Pool to Green Spring, which was in a state of overflow all season. Conditions about the crater indicated an absence of geyser activity. Usually when Green Spring overflows it is accompanied by eruptive activity.

Emerald Pool and Sunset Lake were in essentially the same state as during 1969. As closely as could be determined Cliff Geyser was dormant all season. The water level in the crater remained the same and boiling was constant. Only part of Opalescent Spring showed the color it is famous for.

Myriad Group

As during 1969 Three Sisters Springs were in a state of steady overflow all season. The overflow is from the north crater. In the north crater there are three vents from which geyser activity occasionally occurs. During 1969 and 1970 only the east vent was active. Its intervals during the current season were about every 21 to 23 minutes. The duration of an eruption is about 5 minutes. Maximum height is from 10 to 12 feet.

White Geyser was very active all season. The eruptions occur approximately every 4 minutes, lasting for about a minute. Nearby Round Geyser erupted about every 10 to 14 hours. The eruption is spectacular. It is massive and about 150 feet in height. The duration is short being scarcely more than half a minute. It has a steam phase which lasts for about 5 minutes. It takes several hours for the crater to refill.

Castle and Sawmill Groups

Table Showing Castle's 1970 Summer Activity

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	52	8 hr. 38 min.	9 hr. 9 min.	7 hr. 20 min.
July	75	8 hr. 18 min.	9 hr. 5 min.	8 hr. 12 min.
August	66	8 hr. 38 min.	9 hr. 12 min.	7 hr. 43 min.

During all of the season Castle erupted with considerable regularity. There were a few occasions when splashing preceded the eruption by

over-average time. However, steam-phase eruptions were delayed 3 to 4 times each month by the non-steam-phase eruptions, which were of about 4 minutes duration. The table shows only steam-phase eruptions.

Following the unfortunate accident at Crested Pool, and the use of soap, there was minor eruptive activity every few minutes. This activity gradually subsided. At present the pool in all apparent respects is in the same state as before the incident referred to. Its September temperature was 200°F.

Sawmill Geyser: There was a greater amount of activity in Sawmill in July and August than during early and late season. Like Bonita Pool and its repression of Daisy, Tardy Geyser has the same effect on Sawmill. Since the earthquake Tardy will get in an eruptive state and stay that way for weeks at a time.

Other geysers in this group which were observed to erupt include Spasmodic, Penta, Bulger, Deleted Tardy and Teakettle. At times Oval Spring showed minor eruptive activity. The springs as a whole in the Sawmill Group were less active than during most seasons. There is barely a seep from Liberty Pool. Its temperature is 135°F. Following the earthquake Liberty had minor eruptive activity.

Grand Group

Table Showing Grand's 1970 Summer Activity

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
June	58	9 hr. 10 min.	11 hr. 6 min.	7 hr. 30 min.
July	72	9 hr. 30 min.	13 hr. 47 min.	7 hr. 17 min.
August	85	7 hr. 52 min.	9 hr. 28 min.	7 hr. 10 min.

The pattern of Grand's activity was very similar to that which was established in early July 1969. The first bursts, characterized by rocketing jets, would last from 8 to 10 minutes. During most eruptions there would usually be three succeeding bursts, all of major size.

The number of eruptions during August was unprecedented. This was the first time while I have been in the Old Faithful area when Grand's monthly average was under 8 hours.

Following most of Grand's eruptions Turban and Vent would continue to erupt. However, frequently following Grand's last burst they would drain, to be followed in about half an hour by renewed activity. Concerted action of Turban and Vent continued periodically from two and a half to three hours following Grand's activity.

Chromatic Pool overflowed all season with an inch of ebb in Beauty Pool. Since the 1959 earthquake Chromatic has been in an almost constant state of overflow. Prior to the earthquake there was a frequent shift of the focus of thermal energy between these springs.

Geyser Hill

Along with the Fountain Paint Pot area Geyser Hill continues to be one of the most used by the park visitor of any thermal area in the Park. Its location near Old Faithful is perhaps the main factor in its heavy usage, however, some of the more important geysers are located here.

With the exception of Lioness, Big Cub and Cascade all the major geysers displayed geyser activity during the season. Most of the small geysers, which are numerous, were also active, including Little Squirt, Anemone, Depression, Little Cub, Roof, Beach, North Goggle, Dome, Vault, Aurum, Sponge, Pump, and Infant. Surge and Bench Geysers were not observed to erupt. Bench is a product of the 1959 earthquake. This is the first season since then that it has not been active. In addition to named geysers, three unnamed springs were observed to erupt.

Plume Geyser: Plume continues to erupt with marked regularity. The intervals ranged between 26 and 30 minutes. Most of the intervals were either 28 or 29 minutes. Plume underwent considerable change as a result of the big 1959 tremors. Since then it has been erupting twice as frequently.

Lion Geyser: During June, July and August geyser activity was observed in Lion on 38 different days. This is by far the greatest amount of eruptive activity since the 1957 season. The eruption lasts from 2 to 4 minutes and is from 50 to 60 feet in height.

Beehive Geyser: There was a noticeable decline of activity of this important geyser during the current season when compared with recent years. But 16 eruptions were known to have occurred between May 1 and September 1 - 4 in May, 5 in June 4, in July and 3 in August.

During the 1930s and 1940s there were a number of seasons when Beehive was dormant. The cause of its on-again off-again habit is as yet unknown.

Giantess Geyser: During 1970 to date - September 18 - Giantess has erupted four times. Eruptions occurred on February 13 and February 20. Two eruptions took place in August, on the 1st and again on the 28th. The eruption of August 1 was of the steam-phase type, lasting for about 12 hours. The one on the 28th was water-phase in type, lasting for near 36 hours.

The eruption on August 28 was accompanied by a condition I had never previously observed. This was the first I had ever noted Vault to be active during an eruption of Giantess. During the 28th I observed 3 eruptions of Vault. Two lasted 29 and 30 minutes respectively. The duration of the third was undetermined. When erupting not in concert with Giantess, Vault's eruptions only last for about 4 minutes. The action of Vault greatly decreased the forcefulness of the rocketing of Giantess. On the 29th Vault was quiescent and Giantess put on its usual display.

Old Faithful:

Table Showing Old Faithful's Activity for the 1970 Season

	<u>Number of Intervals</u>	<u>Average Time</u>	<u>Maximum Interval</u>	<u>Minimum Interval</u>
May	220	64.0 min.	95 min.	38 min.
June	304	64.2 min.	90 min.	41 min.
July	366	62.4 min.	90 min.	33 min.
August	<u>354</u>	<u>62.6 min.</u>	<u>89 min.</u>	<u>40 min.</u>
	1244	63.3 min.	95 min.	33 min.

The 63.3 minutes average is the shortest since the 1959 season. From May 1 through September of that year the average time was 62.9. Following the earthquake the intervals began to gradually lengthen. Through December 1959 the average time for 255 determined intervals was 64.4 minutes.