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ZION

A Preliminary Hydrological Assessment of Grapevine Spring, Zion National Park, and a Comparison with Other Springs in the Park

By

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Location: Grapevine Spring is located in the S.W.½ of the N.E.¼, Sec. 28, T.40 S., R.11 W., S.L.B. & M. at an elevation of about 4500 feet above sea level. It flows from the base of a basalt escarpment at the lower end of Cave Valley, where Grapevine Wash joins the Left Fork of North Creek. The easiest access to the spring is by a game trail which lies a few yards west of the lower end of Grapevine Wash, descending about 450 feet.

Previous investigations: Records in the National Park Service files in Zion National Park show that the spring was investigated by S. Bryce Montgomery on 16 February, 1973. His geological report (Montgomery, 1973) includes an estimate of the discharge.

Park Rangers S. J. Phalen and L. E. Brown (a geologist) made general observations and estimated discharge on 7 March, 1973 (Brown, 1973).

This writer visited the spring on three occasions in October and November, 1974.

Hydrological setting: Grapevine Spring flows from the base of a nearly vertical sequence of approximately sixteen basalt flows which apparently were derived from Spendlove Knoll, Firepit Knoll, and other smaller volcanoes in the upper (north) end of Cave Valley during Quaternary (?) time. The lava episodically flooded Cave Valley, partly filling the

canyon of the Left Fork (to a thickness of at least 400 feet of basalt), and blocking the mouth of the Right Fork of North Creek. Subsequently North Creek reincised its canyons, removing most of the basaltic dam, and it is now cutting below the pre-flow stream grade.

Spring flow is from the lowermost interflow clinker and aa horizons as well as from the contact with the sedimentary Moenave Formation, on which the lowermost basalt rests at the elevation of the spring. It is believed likely that the principal aquifer consists of the highly permeable interflow clinker beds which form horizons roughly parallel to the floor of Cave Valley and extending up-valley as far as the volcanoes. Vertical permeability is probably great as well, because of the existence of numerous contraction joints in the basalt. The hydrology of basaltic aquifers is discussed in considerable detail by Visher and Mink (1964) in their evaluation of groundwater flow on Oahu, Hawaii.

The recharge region is Cave Valley, with an area of about 5.1 square miles. It is a shallow upland valley, developed in a graben between the Cougar Mountain Fault (in Lee Valley) and an unnamed fault to the west (in upper Blauk Wash). The surficial deposits on the floor of Cave Valley consist of up to at least 25 feet of sandy alluvium and wind-blown sand including thin lake clays (at a depth of 9 feet in the N.W.$\frac{1}{4}$ of Sec. 16, Hamilton, 1973, unpublished manuscript). This material laps onto and is mixed with weathered volcanic cinders and overlies the relatively unweathered basalt. The basalt probably rests on a certain amount of older alluvial material. The floor of Cave Valley, down to an elevation of about 5250 feet, is developed on Navajo Sandstone. The lower part of the valley, occupied by Grapevine Wash, is formed on

Kayenta sediments down to an elevation of about 4700 feet. Below this level the basalt valley filling rests on Moenave sediments. The lowest flow in the vicinity of the spring rests on the Dinosaur Canyon Member of the Moenave Formation, about 60 feet above the present channel of the Left Fork.

In general, the Kayenta and Moenave rocks act as aquicludes, confining groundwater flow mainly to the permeable surficial deposits, the Navajo Sandstone, and the permeable postions of the basalt. The basalt aquifer is probably of primary importance below about 5250 feet elevation, however the Springdale Member of the Moenave, as well as some permeable sandstones in the Kayenta, may permit removal of a relatively small volume of water in a northeasterly direction, down the 5-degree regional dip slope. Likewise, some groundwater in the Navajo Sandstone may flow northeastward into the Cougar Mountain Fault zone in Lee Valley, however its path is probably blocked in the upper part of the valley by the contact with the Kayenta Formation in the fault zone.

Flow: Previous estimates of flow made by Montgomery (1973) and Brown (1973) are respectively 1.5 ± 0.5 and 2.0 ± 0.5 cubic feet per second. The flow measured by this writer on 17 October, 1974, after a very dry year, was only 0.8 ± 0.1 cubic feet per second. The variability of these measurements is 86 per cent, which bears out an important characteristic of basalt aquifers; that their high permeability makes them subject to rapid response to variations in precipitation, especially

when the recharge area is small.

The average annual infiltration can be estimated, provided that there are no important losses from the Cave Valley aquifer. If the average discharge, represented by the above measurements, is approximately 1.4 cubic feet per second, then the calculated infiltration is 3.7 inches per year. It would appear that evapotranspiration, runoff, and losses from the aquifer could exceed 80 per cent of the annual precipitation.

<u>Water quality</u>: The results of two chemical analyses of Grapevine Spring water are on file in Zion National Park, dated 17 December, 1971, and 20 June, 1974. These data are reproduced here, along with calculated variability

$$\text{variability (percent)} = \frac{\text{(maximum - minimum)}}{\text{average}} \times 100$$

and selected average values for other springs in the Park. These other springs all derive from sedimentary rock aquifers.

Table: Grapevine Spring Water Chemistry

Constituent Measured	Grapevine Spring Values 1971	1974	Variability (percent)	Park Average
Turbidity (JTU)	0.1	0.1	0	0.7
Conductivity (μ U/cm)	415	335	21	
pH	8.25	7.10	15	
Tot. diss. solids	246	226	8	
Alkalinity	140	141	0.7	
Ammonia	-	0.00	?	
Arsenic	0.00	0.00	0	
Barium	0.40	0.0	200	
Bicarbonate	167	172	3	150
Boron	0.31	0.33	6	
Cadmium	0.000	0.000	0	

(cont'd)

(cont'd)

Constituent Measured	Grapevine Spring Values 1971	1974	Variability (percent)	Park Average
Calcium	32	30	6	34
Carbonate	1.6	0	200	
Chloride	8.0	9	12	7
Chromium	-	0.002	?	
Copper	0.00	0.00	0	
Cyanide	-	-	?	
Fluoride	0.14	0.05	95	
Hardness	160	140	13	140
Hydroxide	0.03	0	200	
Iron (total)	0.00	0.06	200	0.05
Iron (filtered)	0.00	0.00	0	
Lead	0.00	0.00	0	
Magnesium	20	16	22	14
Manganese	0.00	0.00	0	
Mercury	0.000	0.0	0	
Nitrate	11.8	2.6	128	0.42
Nitrite	0.0	0.05	200	
Phosphate	0.1	0.06	50	0.07
Phenols	-	-	?	
Potassium	2.0	4	67	2.2
Selenium	0.00	0.00	0	
Silica	26	28	7	11.4
Silver	0.000	0.000	0	
Sodium	19	12	45	6.5
Sulfate	42	10	123	16
Surfactant	0.0	0.00	0	
Zinc	0.00	0.00	0	
Tritium	undetected	-	?	
Nickel	-	0.000	?	

Grapevine Spring water contains significantly more nitrate and silica than the sedimentary rock springs in the Park. Silica would be expected to be enhanced due to the basaltic aquifer, however the nitrate values are so high and so variable that a biological analysis is recommended. It is conceivable that the nitrate indicates contamination from grazing animals or agricultural fertilizer in Cave Valley.

Moreover, whether or not biological contamination is indicated, it is

recommended that an analysis for pesticides be made. These substances are applied in Cave Valley, and because of the rapid response of the ground water flow, they may not be completely degraded in the soil.

The high variability of barium, carbonate, hydroxide, dissolved iron, nitrite, and sulfate suggests that these substances deserve special consideration when later analyses are made.

Uniqueness: Grapevine Spring issues from a basalt flow aquifer and hence is similar to springs in volcanic areas all over the world, such as Thousand Springs on the Snake River Plain in Idaho and Pearl Harbor Springs, in Hawaii.

A similar spring exists at the south end of Lee Valley, about 500 feet southwest of the center of Sec. 15. This spring however is covered with basalt talus, and hence is of secondary scenic value and not as easily recognized as a basalt aquifer type. Moreover, it is believed likely that similar springs may feed into Little Creek, two of the left forks of Russell Gulch, and some of the western headwaters of Wildcat Canyon.

In terms of water chemistry, Grapevine Spring water is significantly less turbid than average for the Park, and it may well contain a uniquely desirable blend of nutrients for certain aquatic organisms.

Its most obvious uniqueness is its beauty, supporting lush vegetation as it does, and it is fortunate that Grapevine Spring is located within a National Park for all to enjoy, without abuse.

References:

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