

## HYDROLOGIC STUDY OF JEWEL AND WIND CAVE

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### Objectives

The research underway has the following objectives:

1. Evaluate the water distribution within these two park areas;
2. Determine the effects of human impact upon the natural hydrologic system;
3. Document any detrimental effects to the water quality;
4. Document any instances in which the cave environment is adversely affected by the quality or quantity of the water present; and
5. Provide options to present water use practices, if necessary.

### Methods

The objectives of the research are being accomplished in three, overlapping phases which were outlined in the proposal. Phase I involves compilation of the available information on the caves' location, geology and hydrology and correlation of that information with the surface topography and the location of all surface hydrologic and artificial features. The goal of Phase I is to compile available information that is currently scattered in various files and individual records and memories.

Phase II is as complete as possible a chemical characterization of the surface and subsurface waters in the two areas. This phase involves chemical analyses of major cation and anion species, selected trace elements, synthetic organic compounds and/or natural and anthropogenic isotopic species in the waters.

Phase III is an investigation of infiltration of surface waters into the caves. Correlation of the chemistries of surface and subsurface waters are yielding some information in this phase but the major tool is dye trace studies.

The details of all three phases are available in the proposal and will not be repeated here. We anticipate that Phase I will be largely completed by the end of the first year and that the resulting maps will need only updating in the

proposed second and third years. Phases II and III will extend through the entire project.

## Results

A significant change occurred in our research plan when Marsha Davis was offered employment as a seasonal employee at Jewel Cave over the past summer. This allowed Marsha to be in the area full time for three months and greatly increased her access to both caves. Marsha's stay at Jewel Cave significantly increased the amount of work we were able to accomplish within the context of the study.

The compilation of data under Phase I is well underway. Marsha was able to obtain information on the cave maps, inventories and engineering drawings of various facilities at the two caves. This information is currently being redrafted to a common scale for direct comparison. The search of the various information sources have identified a few gaps in the available information. We were unable to find any good maps of the resurgent springs which are the outlets of the hydrologic systems. We therefore are mapping the springs as part of this project. Figure 1 is the map we have prepared of the resurgence of Beaver Creek at Buffalo Gap. A very complex pattern of resurgences was found which will have a profound impact on any dye traces to this spring. Note the different temperatures of the various rise points. This data indicated that several different flow paths emerge in this one rise area.

Phase II is well ahead of schedule. During the first half of this study we have analyzed: (1) 2 water samples for volatile synthetic organic compounds, (2) 2 water samples for  $^{14}\text{C}$  and  $^{13}\text{C}$  isotopic analyses, and (3) 61 water samples for major and selected minor and trace cations and anions. We have only begun our interpretation of the chemical analyses and the following observations are very preliminary.

The two analyses for synthetic organic compounds were made on the public water supplies of Wind and Jewel Caves to test for immediate health threats. Both analyses were, happily, negative. The two isotopic analyses were made on direct samples of the two areas' water supply wells. The two wells yielded remarkable similar  $^{14}\text{C}$  and  $^{13}\text{C}$  data which indicate short, probably less than 30-year residence time for the groundwaters.

Figure 2 illustrates the major cation compositions from the water analyses. The initial observation is that the waters in the two cave areas are fundamentally different with the waters from Jewel Cave distinctly more magnesian than the waters from Wind Cave. The waters from Wind are the calcium dominated compositions to be expected from the dissolution of limestone and dolomite. The waters from Jewel Cave contain more magnesium than can be explained by the simple dissolution of dolomite or calcite. Either the dissolution process is considerably more complex and/or additional phases are involved.

There are suggestions that the nitrate and boron data may prove to be useful indicators of surface contamination but final interpretation of these results will

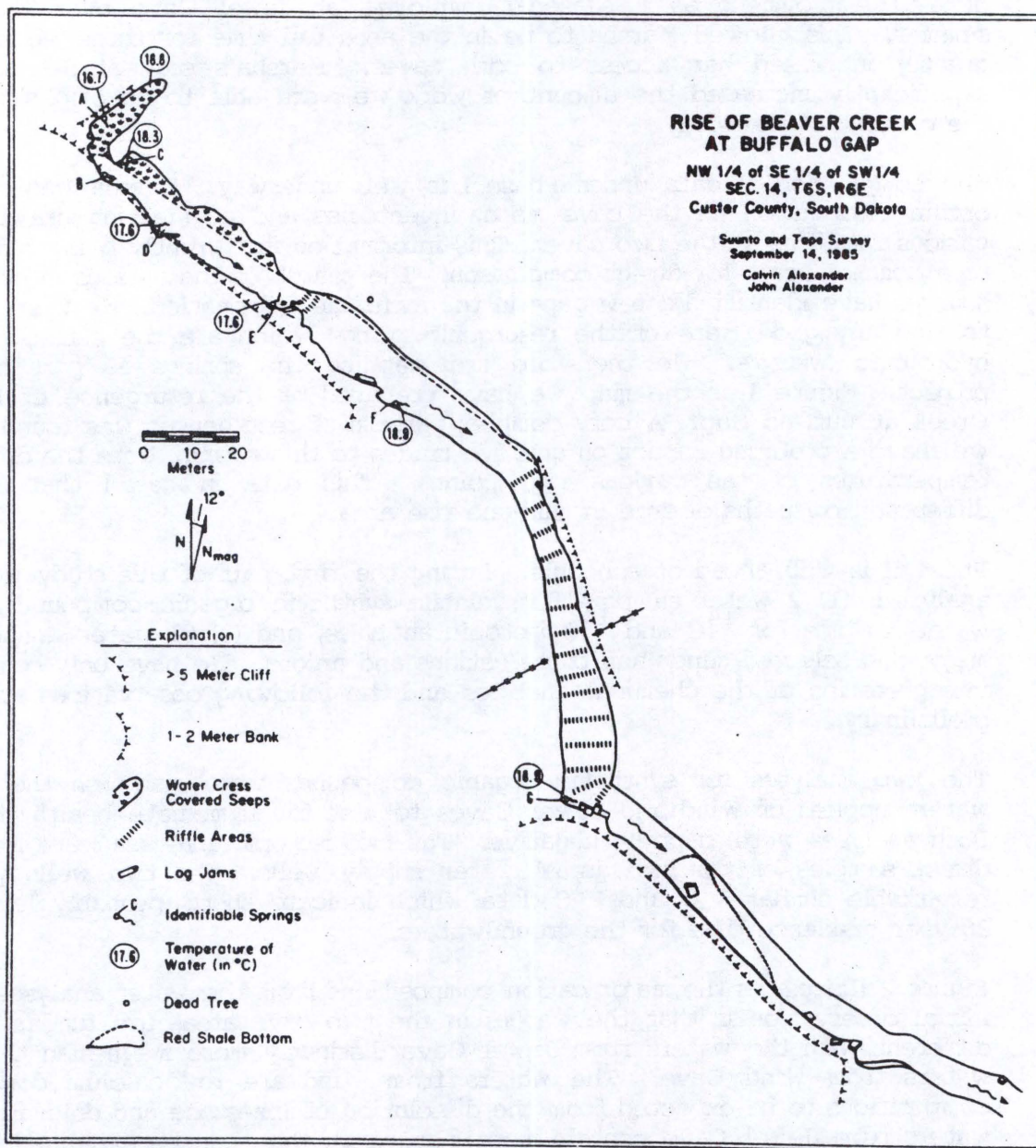


Figure 1. Plan view of the Rise of Beaver Creek at Buffalo Gap.

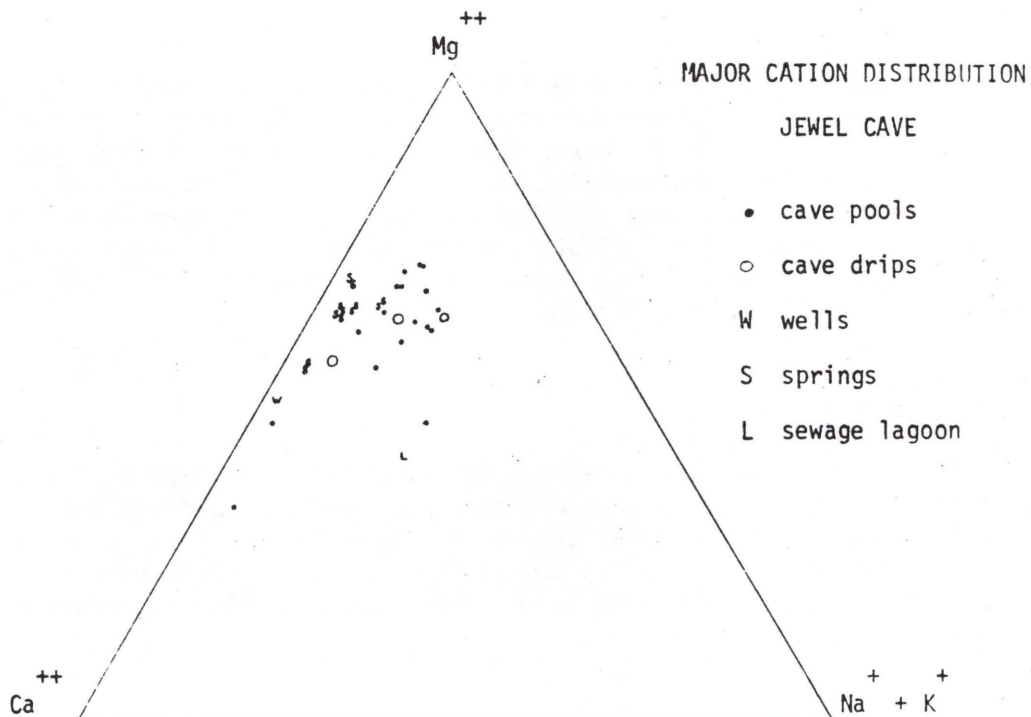


Figure 2a. Cation distribution diagram for waters collected in and around Jewel Cave National Monument.

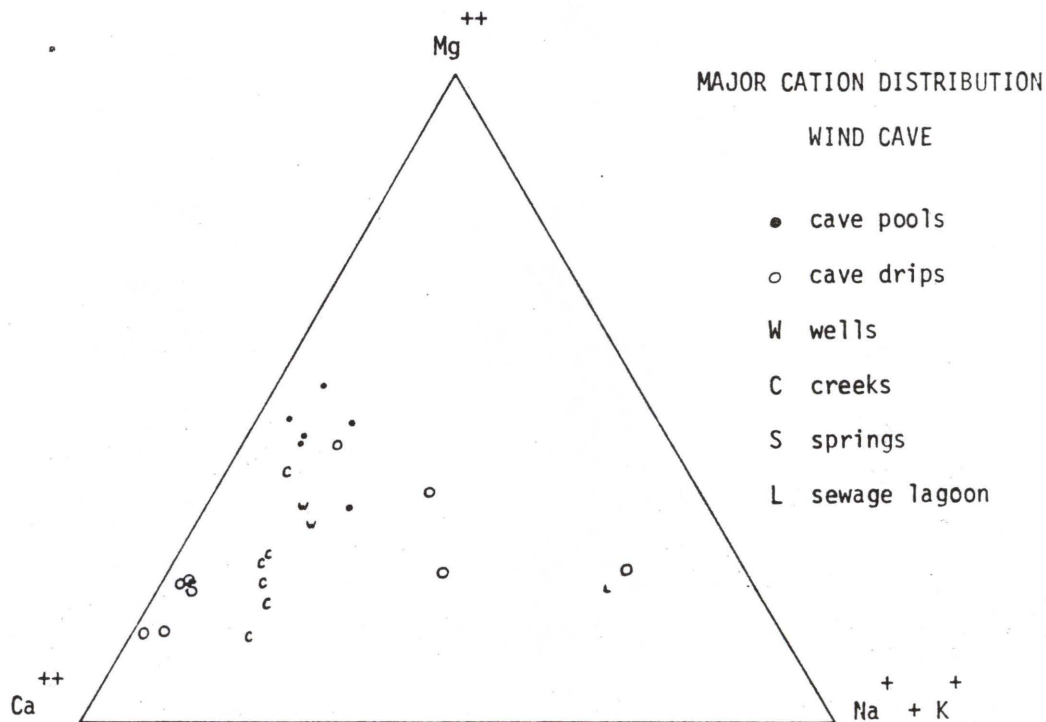


Figure 2b. Cation distribution diagram for waters collected in and around Wind Cave National Park.

require additional data.

Phase III has been successfully started. We initiated our first dye trace under Phase III in September. Rhodamine WT, a fluorescent dye, was literally flushed down the toilets at Jewel Cave. Figure 3 shows a small part of our data from drips and pools in Jewel Cave. One "pulse" of dye has been detected in the New Wet Area-West and two "pulses" of dye have been detected in the New Wet Area-East. These results are typical of several areas within the cave. These results provide direct evidence that effluent from the Monument's sewage system is reaching the cave.

### Conclusions

It is clear at this stage that the surface development at the Park and Monument are affecting the caves' hydrologic system. The efforts at both facilities to improve and upgrade the sewer systems are very important and should be continued and accelerated. Although not yet documented, runoff from parking lots etc., will probably also prove to be a problem requiring attention.

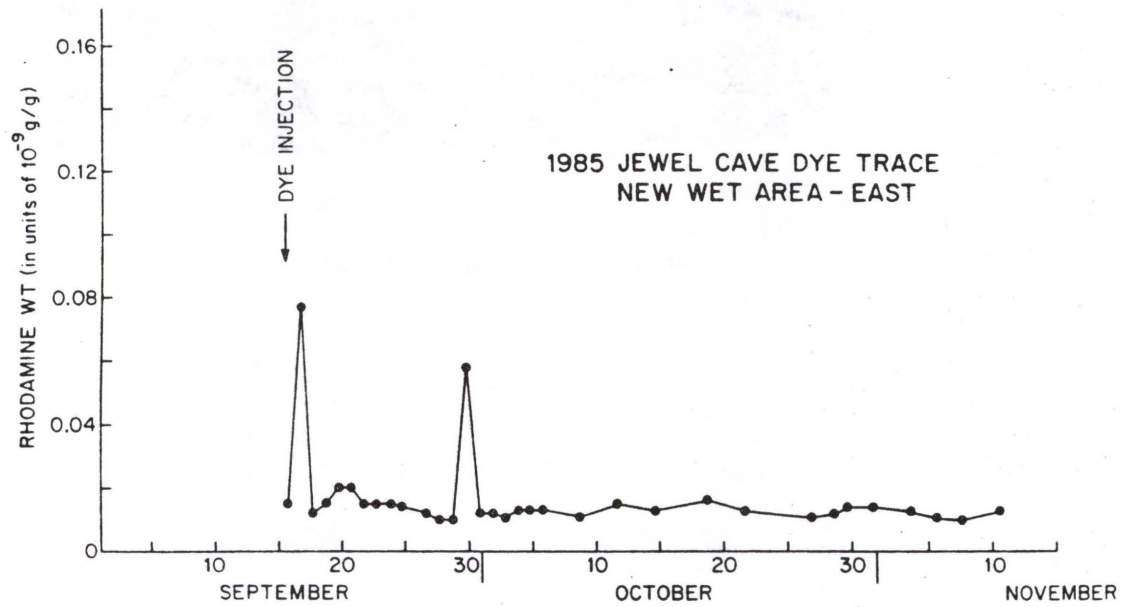
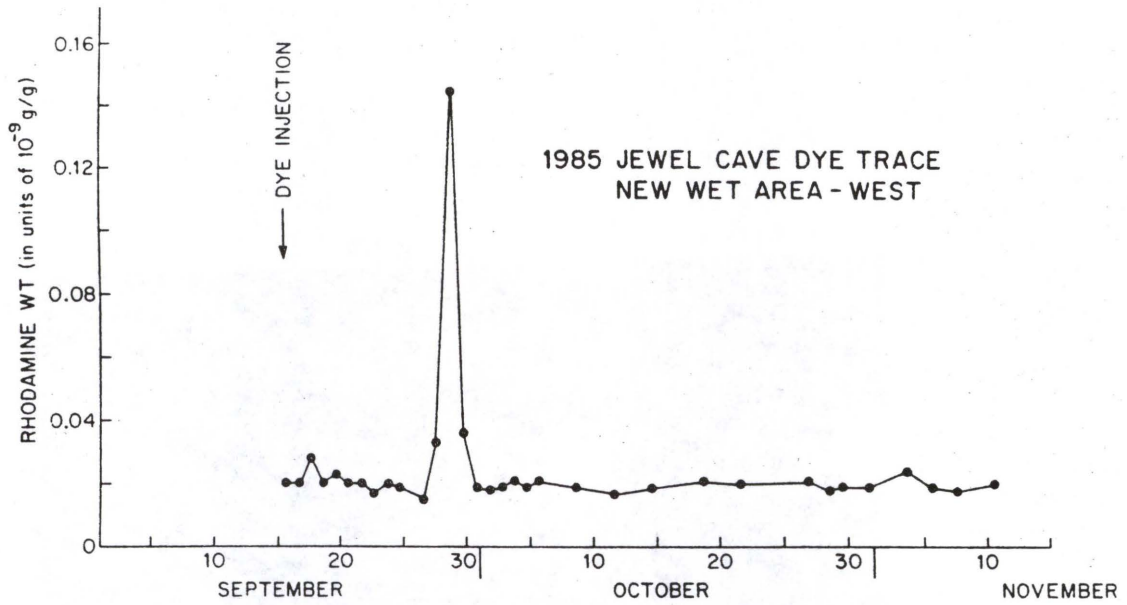


Figure 3. Initial results from 1985 Jewel Cave Dye Trace for Two selected drips in the New Wet Area.