United States Department of the Interior

GEOLOGICAL SURVEY

Branch of Western Regional Geology
2255 North Gemini Drive
Flagstaff, Arizona 86001

November 19, 1991

Memorandum

To: Dave Wegner

From: Richard Hereford

Subject: Highlights of October 28-November 16 Research Trip

This is a brief report of our activities. The trip was generally quite successful and we were able to resolve several apparent problems and gain important new insight into erosion of archeologic sites. Much of the success can be attributed to the interested and hard working personnel--Kirk Anderson (volunteer geomorphologist), Diana Elder Anderson (volunteer geomorphologist), Glenn Rink, and Kate Thompson (hopefully not a volunteer). Helen Fairley provided archeologic expertise for us and carried out her research as well. She was instrumental in identifying an archeologic feature eroded by the 1983 flood at the Upper Unkar Site (Furnace Flats). In addition, the Oars crew, Greg Williams and Dorry Stonebreaker, did an excellent job. The lack of a sport boat cost us time, as it increased time spent walking to and from several study areas. However, this was not serious, especially considering the exorbitant cost of taking a sport boat. I was told that Oars would have charged $6,000 to put a sport boat on the trip.

Most of my time was spent mapping the surficial geology of the Palisades Creek and Tanner Wash study areas utilizing the recently completed large-scale topographic maps. In addition, I supervised several stratigraphic studies at these localities. These studies were undertaken to analyze sedimentologic evidence of large floods at Lava Creek and Tanner Wash and to determine the dates of large debris flows at Palisades Creek.

Results of earlier work indicated that a backwater flood sequence is preserved at the mouth of Lava Creek. Our dating indicates that deposition of the sequence occurred from about A.D. 1400 to 1880. The objective this trip was to collect additional sedimentologic data in order to identify specific flood deposits. It's possible that 15 floods are present in the sequence. These were large floods, probably 300,000 $ft^3 s^{-1}$ or greater. In which case, the frequency of such large floods might have been higher than indicated by the historic flood record.

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At Tanner Wash, we investigated a much older flood sequence dating from about B.C. 200 to A.D. 300-400. This sequence is dated radiometrically from charcoal associated with Archaic to Basketmaker II occupation of the area. Again, the problem was to identify specific flood deposits occurring between several dated stratigraphic horizons. Our goal in both cases is to understand past flood frequencies at the archeologic sites as a means of understanding the effects of large floods on the sites and to gain better understanding of flood frequencies.

Our studies of debris flow stratigraphy at Palisades Creek, and elsewhere for that matter, have been particularly interesting. The goal has been to understand the timing and number of debris flows present in the Palisades Creek debris-flow fan. These were large debris flows that spread 1-2 m of sediment across the entire fan area. In contrast, debris flows of the past 100 years have been significantly smaller and were largely confined to debris-flow channels (Palisades Creek). In short, we are dealing with what I call "fan-forming debris flows." Flows of this size are capable of dramatically increasing the areal extent and height of the entire fan; in addition, they would have a significant long-term effect on rapids. These debris flows are relatively old judging from radiometric data and their relation to PII archeologic features. Three large debris flows occurred at Palisades Creek from about A.D. 950-1880. Thus, a recurrence interval of one flow about 300 years is indicated. Under natural flow conditions, the river might take several hundred years to clear the channel of debris.

Finally, I think we made a major breakthrough in understanding erosion of archeologic features in the four study areas as related to regulated flows. This breakthrough has been slow coming because heretofore large-scale topographic maps were not available and the archeologic features were not identified. In the following paragraphs, I'll attempt to explain briefly the "baselevel model" of erosion, which I will summarize fully in the EIS Interim Technical Report due December 31.

At the four study areas, most of the features are exposed and eroding in the arroyos of short tributary streams of the Colorado River. Regulated flows are not directly implicated because only one feature is within the 1983 flood zone and none of the features are within the zone of fluctuating flows. Thus, erosion of the features results from arroyo cutting of the short tributary streams. This cutting causes the channels to deepen, widen, and extend headward. The arroyo cutting process is initiated by runoff from rainfall in the nearby hillslopes.

The baselevel of a particular stream determines whether regulated flows have effected erosion. Drainage patterns on the large-scale topographic maps show that these short tributaries drain to either the Colorado River or to the low terraces in the old high water zone. In the latter case, arroyo cutting is unaffected by the baselevel of the river; erosion of archeologic features in these streams is unrelated to regulated flows of the post-dam era. In the former case, however, the baselevel of the river

controls arroyo cutting. The post-dam baselevel is substantially lower than the pre-dam level, a result of regulated, clear-water flows. Thus, when triggered by heavy rainfall, these streams will regrade through arroyo cutting to the new, lower baselevel.

In short, erosion of some archeologic features resulted from stream adjustment to lowered baselevel, which in turn resulted from post-dam regulated flows. Utilizing the large-scale topographic maps and geologic information, we can identify streams that are graded to the river. From these observations, we can probably make generalizations about what percentage of a given site was and will continue to be effected by lowered baselevel.

cc: J. Balsom
H. Fairley