Annual Report FY 1993

Cooperative Agreement for Development of a Monitoring Program of Sediment Storage Changes in Alluvial Banks and Bars, Colorado River, Grand Canyon

Agreement 2-FC-40-12880

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ABSTRACT

During the past year, progress was made in preparing surficial geologic base maps of Reaches 1, 2, 3, 4, and 5. These maps are in the final stages of field and office checking before digitizing begins into the GCES GIS data base framework. Field work has not yet been initiated in reaches downstream from Phantom Ranch . Staffing changes have occured on this project which have slowed the progress of the overall effort.

INTRODUCTION

The purpose of this project is the development of a baseline from which GCES can continue comprehensive monitoring of alluvial deposit change in each of the GIS reaches of Grand Canyon National Park. The advantage of air photo analysis is that it permits comprehensive analysis of change of all shorelines and can be undertaken without substantial field work, once initial mapping has been completed. The other advantage of this monitoring strategy is that change can be compared with similiar maps of change determined from historical air photos, thus permitting present changes to be placed in a long-term context. The most significant drawbacks of this type of approach are (1) the time-consuming nature of initial base map preparation, and (2) the limitation to planimetric analysis of bar change. Thus, the ultimate analysis of bar change in Grand Canyon will involve an intentional integration of the results of this project with those of oblique rephotography (Dexter and Cluer) and topographic resurveys (Beus and Kaplinski). Since these projects are well underway, GCES is well positioned to have the components of a truly comprehensive monitoring program for alluvial deposits at the completion of FY94.

The specific purposes of this project are to (1) provide GCES with the initial surficial geologic base maps from which future change can be determined, and (2) provide GCES a set of historic maps of past bar status from which the significance of future bar changes can be evaluated.

Results from this project will also be critical in the development of working hypotheses concerning the effects of a planned experimental flood in March 1995. By comparing the status of bars in different years, we have shown in previous work (Schmidt, 1992, Historic changes in sediment deposits in Grand Canyon, in S. S. Beus and C. C. Avery, eds., The Influence of Variable Discharge Regimes on Colorado River Sand Bars below Glen Canyon Dam: report to NPS) that the inherent tendency of bars to aggrade or erode in response to floods and fluctuating flows can be determined. As part of the experimental flood planning process, we intend on developing a set of scenerios of the types of channel geometries that give rise to stable and unstable bars. These scenerios

will permit hypothesis generation about the expected impacts and effects of the March 1995 flood.

BACKGROUND

The methods used in this project were developed by Schmidt (1992). The techniques of systematic analysis of the condition of alluvial deposits in different historical air photos was initially undertaken by Howard and Dolan (1979, Changes in the fluvial deposits of the Colorado River in the Grand Canyon caused by Glen Canyon Dam, in R. M. Lin, ed., First Conference on Scientific Research in the National Parks, v. 2: NPS Transactions and Proceedings Series, 845-851). Schmidt's (1992) adaptations essentially involve (1) utilization of a detailed base map series not available to Howard, (2) interpretation of many more air photo series, and (3) mapping of geologic units [Howard had only mapped shorelines]. At the inception of this project, a revised set of mapping units was developed that constitute a significant refinement of those reported by Schmidt (1992). Our mapping concentrates on river deposited alluvium, primarily at stages lower than 100,000 ft^3/s stage. Hereford (1993, Map showing surficial geology and geomorphology of the Palisades Creek archeologic area, Grand Canyon National Park: USGS Open-file report 93-553) has concentrated on delineations of debris fan and high terrace deposits. In areas where these two efforts overlap (e. g. Palisades Creek area), mapping results are comparable, but each effort provides differing detail about the deposits of particular concern to each mapping program.

METHODS

The principal methods of this project are those of geologic mapping -- field description and analysis and aerial photograph interpretation. Preliminary analysis of air photos is conducted in the office. At that time, interpretation of all available air photos is undertaken and mapping is transferred to the common 1:2400 scale of the GIS topographic base map series. Field work is subsequently conducted to check preliminary designations. Maps are then revised, checked again in the field, and then digitized into an ARC-INFO data base that is compatable with the GIS system that exists at GCES. Care is taken to withhold maps from the digitizing stage until maps are fully checked, so as not to require re-editing. After entry into ARC-INFO, maps are compared from year-to-year to determine the nature of alluvial deposit change.

RESULTS TO DATE

Preliminary surficial geologic maps (1990 and 1992) have been prepared for all maps in Reaches 1, 2, 3, 4, and 5. In reaches 1 and 2, final field checking has not been undertaken. Maps in Reaches 3 and 4 have been checked for a second time and final compilation, prior to digitizing, is presently underway. Approximately half of Reach 5 has been field checked for a second time and is now being compiled. Historic maps, based on old air photos have been completed for most of these reaches, and their finalization awaits final compilation of the 1990 and 1992 series.

Figure 1 is a compilation of mapping in part of Reach 3 showing the close association of eddy flow patterns with separation and reattachment bars. Map units shown on this figure are compiled from detailed maps of the same reach, such as the example map included as Plate 1 (folded and attached). One of the critical results of this project to date is the demonstration that the classification proposed by Schmidt (1990) can be used to comprehensively map reaches and that the vast majority of alluvial deposits in Grand Canyon are formed by eddy flow processes.

Preliminary inspection of these maps indicates the following:

1. the overall scale of sand bar change since establishment of interim flows has been small;

2. the general nature of change has been to redistribute sand within eddy complexes from high elevation to low elevation; and,

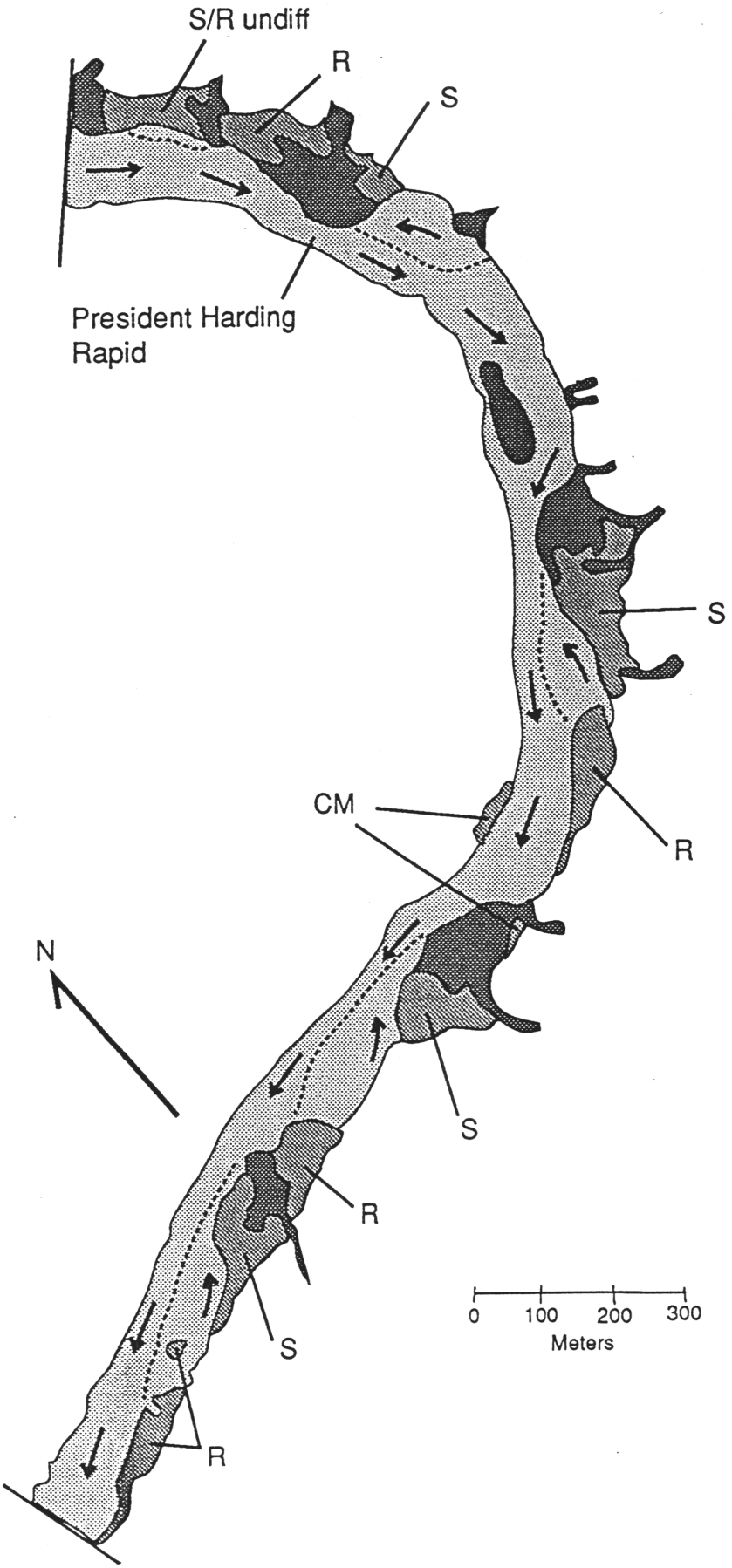
3. sites where sand existed on 1973 air photos and which were sites of net erosion during high discharges between 1983 and 1986 have been sites of sediment accumulation since 1990.

These conclusions are consistent with findings of Beus and Kaplinski (1993, quarterly report) and are an example of how the results of these two projects complement each other. Our mapping demonstrates that the results of Beus and Kaplinski can be extrapolated more extensively in Grand Canyon.

DISCUSSION OF PROGRESS AND PROJECT TIMETABLE

I estimate that we are about 6 mths behind schedule on this project. As is evident from the project budget, this project was to have been conducted within the context of completion of a graduate student thesis, and personnel costs were almost entirely allocated to graduate student and technician support and the costs of the GIS laboratory. Good progress was made in spring and summer 1993 in preparing initial maps for Reaches 1, 2 and 3. In September 1993, we essentially completed all necessary field work in Reaches 3 and 4. The decision of the graduate student-in-question to leave this

project as of October 1, however, has meant that the compilation process has been seriously delayed. The timing of this departure was unfortunate because it came when I was completely enmeshed in GCES Senior Scientist activities and the completion of field work elsewhere in the Colorado River basin. After a period of adjustment and reevaluation of the status of the project, I have hired a geology technician (he has an MS in geology) to assist me in map compilation. I have come to the conclusion that that this project can only be completed with a substantial reallocation of my own time. In light of the commitment of people already made and the commitment of significant USBR financial resources, I am determined to complete this project in good order despite our present delays. I will be submitting a revised Project Timetable to D. L. Wegner, GCES Program Manager, by January 15, 1994, outlining a revised plan for project monies and a revised design of allocation of personnel costs that will ensure project completion.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