

Holocene Evolution of Canyons and Implications for Contaminant Transport, Pajarito Plateau

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Abstract—The preserved Holocene geologic record in canyons incised into the Pajarito Plateau indicates that sediment is cycled through canyons on time scales of tens to hundreds of years. Canyon stream systems draining the Sierra de los Valles and Pajarito Plateau exhibit episodic sediment transport and deposition during the Holocene, including multiple episodes of incision and aggradation during Holocene and recent (historic) time. Formation of a mid-Holocene fill terrace in Frijoles, Rendija, Los Alamos and Bayo canyons suggests that both the larger canyon systems draining the Sierra de los Valles (e.g., Frijoles and Los Alamos Canyons) and smaller canyons heading on the Pajarito Plateau (e.g., Rendija and Bayo Canyons) are responding synchronously to local or regional climatic changes. Although detailed correlations of the multiple late Holocene and historic surfaces between canyons has not been completed, the presence of Holocene valley floors indicates significant Holocene sediment storage in canyons on the Pajarito Plateau. Canyons examined contain between 3 and 6 ft of sediment less than 50 yrs old in some locations, and also contain one or more inset geomorphic surfaces of historic age. The late Holocene and historic record of multiple cut-and-fill events indicate that the potential exists for remobilization and transport of contaminants through canyon systems. Contaminants discharged into canyons discussed in this paper include (1) ^{90}Sr , natural and depleted uranium dispersed throughout a segment of Bayo Canyon during munitions testing; (2) plutonium discharged into Acid Canyon and transported into Pueblo Canyon; and (3) plutonium released into DP Canyon. Contaminants entrained as part of the sedimentary package have been transported through canyon systems; in Pueblo Canyon contaminants have been transported downstream through Los Alamos Canyon to the Rio Grande.

INTRODUCTION

Geomorphic mapping conducted in Bayo and Los Alamos Canyons provides a stratigraphic framework for comparison with the geomorphic and Holocene geologic record in DP, Frijoles, Pueblo, Rendija and Cabra canyons (Drakos and Inoué, 1993, 1994; Graf, 1995, unpubl. reports to Los Alamos National Laboratory; Reneau, 1993; Reneau and Gardner, 1993; Graf, in press; Fig. 1). These canyons were examined as part of the

Environmental Restoration Project at Los Alamos National Laboratory (LANL). The purpose of the geomorphic mapping conducted in the vicinity of LANL was to: (1) define historic and prehistoric Quaternary geomorphic surfaces through surface mapping at 1:1200 scale; (2) identify discrete stratigraphic units within the alluvium and colluvium and associated geomorphic surfaces and to identify areas of historic erosion and deposition; (3) estimate sediment transport rates; (4) identify potential contaminants within a canyon system; and (5) identify specific geomorphic units and underlying sediments as sampling locations for potential contaminants. An additional outcome of these investigations was the development of the Quaternary geologic history of individual canyons.

The geomorphic characterization of canyon segments involved field mapping, air photo analysis, profiling using a hand level and stadia rod, field soil and stratigraphic descriptions, and analysis of topographic maps and drillers' logs. Geomorphic features examined include drainage channels, areas of historic sedimentation and terrace formation, older sedimentary deposits and geomorphic surfaces along the valley floor, and talus or colluvial slopes between the valley floor and adjacent cliffs. Geomorphic surfaces were differentiated based on height above local base level, radiometric dating, the presence or absence of historic materials in the underlying deposits, the degree of preservation of depositional or constructional morphology, and where possible, relative soil development. A series of 1:1200 scale geomorphic and Quaternary geologic maps of the areas of Bayo, Los Alamos and DP canyons are available from LANL Facility for Information Management, Analysis, and Display (FIMAD).

GEOLOGIC SETTING

Canyons on the Pajarito Plateau in the vicinity of Los Alamos are incised into a sequence of the Tshirege Member of the Bandelier Tuff, overlying the Cerro Toledo interval and Otowi Member of the Bandelier Tuff (Fig. 2). The Bandelier Tuff ranges in age from 1.2 to 1.6 Ma, based on $^{40}\text{Ar} - ^{39}\text{Ar}$ dates for the Tshirege Member (1.2 Ma) and the Otowi Member (1.6 Ma) (Izett and Obradovich, 1994). The Otowi Member of the Bandelier Tuff is underlain by alluvial fan deposits that comprise the Plio-Pleistocene Puye Formation, Pliocene basaltic rocks of the Cerros del Rio volcanic field, and Santa Fe Group (Tesuque Formation) sediments.

Canyon incision into the Pajarito Plateau commenced during the Pleistocene following deposition of the Bandelier Tuff (Tshirege Member) at 1.2 Ma. In several canyons (e.g., Cabra, Los Alamos, Mortandad and Ancho

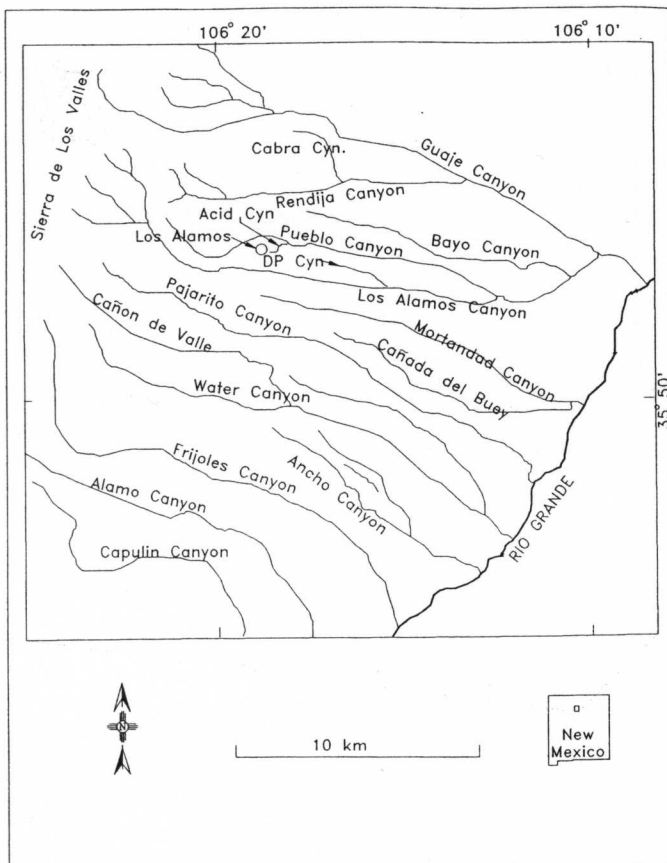


FIGURE 1. Map showing selected drainages on the Pajarito Plateau (adapted from Reneau et al., this volume).

