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ABSTRACT

At the Nevada Test Site, one potentially disruptive scenario being evaluated for the Greater Confinement Disposal (GCD) Facility Performance Assessment is deep post-closure erosion that would expose buried radioactive waste to the accessible environment. The GCD Facility located at the Area 5 Radioactive Waste Management Site (RWMS) lies at the juncture of three alluvial fan systems. Geomorphic surface mapping in northern Frenchman Flat indicates that reaches of these fans where the RWMS is now located have been constructional since at least the middle Quaternary. Mapping indicates a regular sequence of prograding fans with entrenchment of the older fan surfaces near the mountain fronts and construction of progressively younger inset fans farther from the mountain fronts. At the facility, the oldest fan surfaces are of late Pleistocene and Holocene age. More recent geomorphic activity has been limited to erosion and deposition along small channels. Trench and pit wall mapping found maximum incision in the vicinity of the RWMS to be less than 1.5 m. Based on collected data, natural geomorphic processes are unlikely to result in erosion to a depth of more than approximately 2 m at the facility within the 10,000-year regulatory period.

INTRODUCTION

At the Nevada Test Site (NTS), one potentially disruptive scenario being evaluated in the Greater Confinement Disposal (GCD) Facility Performance Assessment (PA) is post-closure erosion that would expose buried radioactive waste to the accessible environment (1,2). The GCD Facility is located at the Area 5 Radioactive Waste Management Site (RWMS) in Frenchman Flat, along the eastern boundary of the NTS. This closed basin formed since the middle Miocene (3,4). Alluvium in northern Frenchman Flat is late Miocene to Holocene, with most of the landscape covered with Quaternary alluvium. The RWMS is located at the juncture of three coalescing alluvial fan systems: the Scarp Canyon and Nye Canyon (SC-NC) fan piedmont from the northeast; the southern Halfpint Range and Massachusetts Mountains (SHR-MM) fan piedmont from the north and northwest; and the Barren Wash fan from the west. The Quaternary history of these three prograding fan systems is most relevant to the discussion of erosion and landscape evolution at the RWMS. This paper outlines the surficial geologic history at the RWMS and its implications for future landscape development.

SURFICIAL GEOLOGY

Preliminary geomorphic surface maps have been completed for northern Frenchman Flat. This 1:6000-scale mapping used aerial photographs and field mapping to determine boundaries and composition of map units. Criteria for defining the various geomorphic surfaces include relative geomorphic position, landform morphology, and degree of preservation of

surface morphology (5, 6). Seven major geomorphic surfaces are recognized in northern Frenchman Flat. These surfaces range from early Quaternary to historic in age (Table 1).

Geomorphic Surface	Geologic Age
S7 and S6	Late Holocene
S5	Middle Holocene to Late Pleistocene
S4	Late Pleistocene
S3	Middle Pleistocene
S2	Early Pleistocene

Table 1. Estimated Ages for Geomorphic Surfaces Mapped in Northern Frenchman Flat. Based on Correlations of Similar Mapping Criteria Used at Midway Valley, Nevada Test Site (5,6).

The most dramatic geomorphic features in northern Frenchman Flat are related to evolution of the SC–NC fan piedmont. It is characterized by broad areas of the oldest geomorphic surfaces (S2 and S3). Drainage patterns and clast provenance of the S2 and S3 surfaces indicate that Nye Canyon was the principal source for the alluvium issuing into northern Frenchman Flat in S2 and S3 time. Subsurface investigations indicate these deposition extended to the RWMS (7). Subsequent incision of these old surfaces began in either late S3 or early S4 time. Evidence for this is that S3 surfaces are the youngest fan surfaces entrenched and that terrace remnants with S4 surfaces are the oldest deposits preserved in the canyons. Presumably this incision of Scarp and Nye canyons was climate-driven during late S3 (glacial?) time. The deep fan-head incision means that these canyons continue to distribute water and alluvium to an inset fan (S4–S7 surfaces) downslope of the RWMS (Fig. 1).

Incision of the SC–NC fan piedmont has left the S2 and S3 surfaces as relict fan surfaces. Subsequently, surfaces of S4 and S5 age have formed at the RWMS as a result of: 1) internal drainage on the broad S3 surface; and, 2) drainage along the southeastern flank of the Halfpint Range being directed southwest along the boundary between the SC–NC and SHR–MM fan piedmonts. These surfaces are within the Halfpint Alluvial Fan (Fig.1) of Miller *et al.* (8). This area of deposition and the erosional landscape upslope is an active drainage subbasin, with most recent geomorphic activity limited to erosion and deposition along small channels (S6 and S7 surfaces).

Geomorphic mapping of the SHR–MM fan piedmont indicates a regular sequence of prograding fans with entrenchment of the older fans near the mountain fronts and construction of progressively younger inset fans farther from the mountain fronts. At the RWMS, the oldest fan surfaces are of S4 and S5 age. More recent geomorphic activity (S6 and S7 surfaces) has been limited to erosion and deposition along small channels.

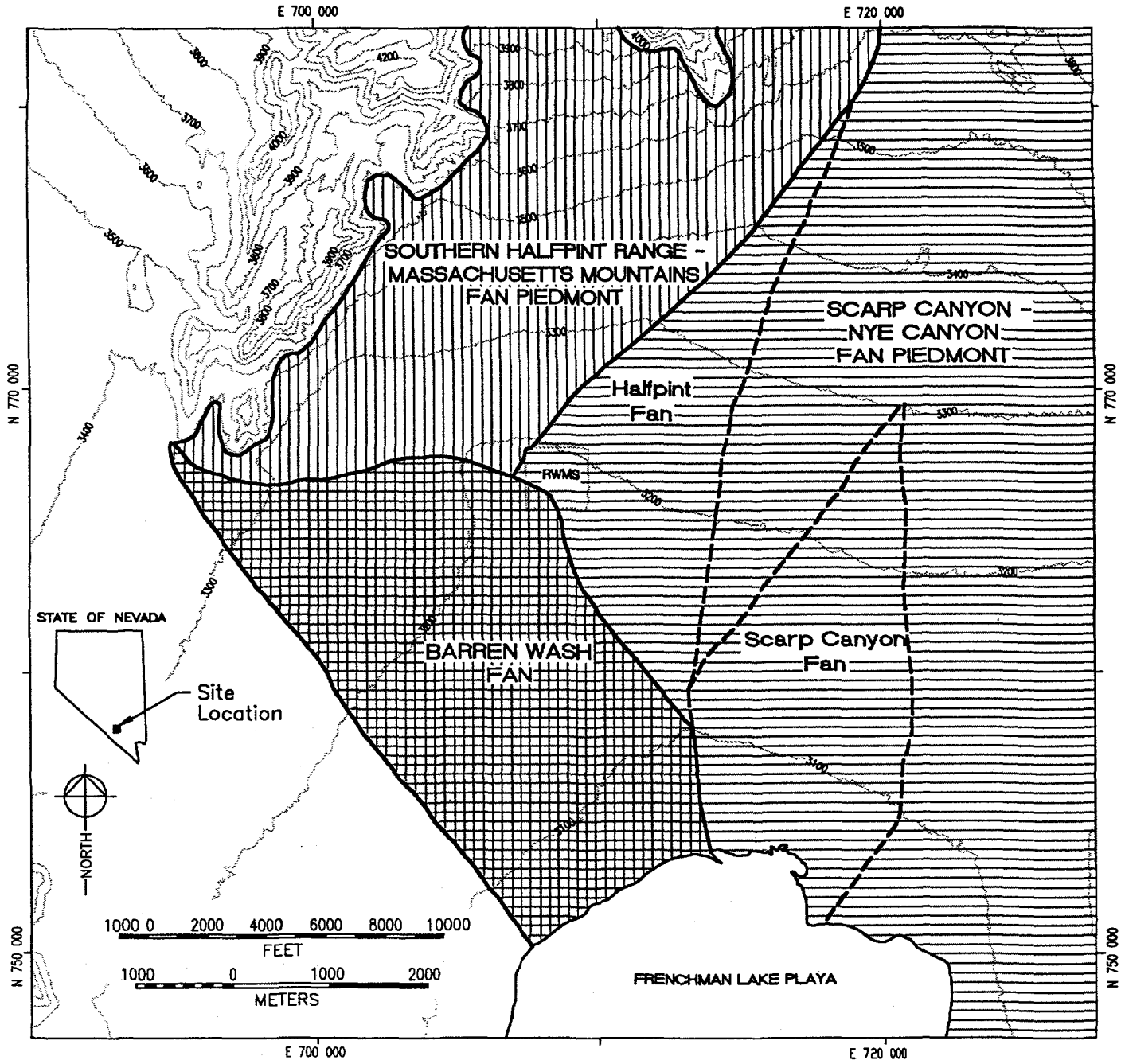

Figure 1. Major Landforms of Northern Frenchman Flat, Nevada Test Site. Modified from Miller *et al.* (8).

Although Barren Wash watershed drains a large part of western Frenchman Flat basin (8), only a small part of this large fan system is within the study area (Fig. 1). The particular fan of interest issues from the west around the southern tip of the Massachusetts Mountains and converges with the other two fan systems at the RWMS. Much of the fan consists of S3 and S4 fan remnants. As with the other two fans, the most extensive surface near the RWMS is of S5 age, with more recent geomorphic activity (S6 and S7 surfaces) being limited to erosion and deposition along small channels.

CHANNEL EROSION

Although geomorphic mapping indicates that the RWMS has been a point of net aggradation since at least S3 time, local incision and local aggradation have been active geomorphic processes even in the depositional portion of these alluvial fans. Detailed mapping of pits and trenches at and near the RWMS provide insight into the type and depth of past channel incision.

At the RWMS, 425 m of pit walls were mapped and sampled to obtain detailed near-surface information about the alluvium to depth of about 8 m (7). This conglomeritic to fine-grained alluvium represents deposition on the lower-middle to distal part of a large fan issuing into Frenchman Flat from the northeast. The alluvium displays characteristics typical of sediments deposited by sheet-floods, in stream channels, and as thin debris flows. Field observations indicate that the landscape at the RWMS has developed by planation by relatively shallow streams rather than by deep stream incision and backfilling. Cross-sectional measurements indicate that paleochannels are less than 1 m deep and typically less than 0.5 m deep.

The four trenches mapped near the RWMS are located at or below the intersection points of the SC-NC and SHR-MM fan piedmonts. Based on measurements of paleochannels and reconstruction of soil profiles at these trenches, the maximum depth of incision was approximately 1.5 m (9, 10). Most of the erosion was less than 0.8 m deep. These depths are similar to data from the pit walls at the RWMS.

CONCLUSIONS

The RWMS Facility lies at the juncture of three alluvial fan systems. Geomorphic surface mapping in northern Frenchman Flat indicates that since at least S3 time, the RWMS has been located in the constructional reaches of these three fan systems. Furthermore, mapping indicates a regular sequence of prograding fans with entrenchment of the older fans near the mountain fronts and construction of progressively younger inset fans farther from the mountain fronts. At the RWMS, the oldest fan surfaces are of S4 and S5 age. More recent geomorphic activity (S6 and S7 surfaces) has been limited to erosion and deposition along small channels. Trench and pit wall mapping found maximum incision in the vicinity of the RWMS to be less than 1.5 m. Based on collected data, natural geomorphic processes are unlikely to result in erosion to a depth of more than approximately 2 m at the RWMS within the 10,000-year regulatory period.

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