numerous other geological discontinuities that induce weathering and the generation of flows that transport material to the fan, rapidly enlarging the drainage basin. In contrast, neighbouring fans display developmental Stages 1 or 2 depending on the position of their drainage basins with respect to minor discontinuities in the uplifted block. The fans in the vicinity of Copper Canyon in Death Valley also exemplify this scenario (Fig. 14.18). The largest and most developed (Stage 2) fans have the largest and most structurally complex drainage basins from which significant sediment is produced. The smallest fans in this area, in contrast, have small and unstructured drainage basins and have reached only Stage 1 in their evolution.

The typical fan stage does bear consistency along basin margins. For example, the fans in southeastern Death Valley exhibit Stages 1 or 2 of development, whereas the fans across the valley along the Panamint Mountains all have reached Stage 3 (e.g. Fig. 14.3a and d). This relationship is caused by active and recent offset along the mountain-front fault on the eastern side of the basin, which has caused lacustrine transgression and burial of fans, initiating a new tectonic cycle (Blair 1985, 1987b). In contrast, the Stage 3 fans along the Panamint Mountains have been developing for a significantly longer period of time due to their position along the inactive side of the asymmetric Death Valley half graben.

CONCLUSIONS

Alluvial fans are common landforms of deserts, occurring where a channel emerges from an upland drainage basin to a tectonically controlled mountain front and valley. Primary processes that construct fans are rockfalls, rock avalanches, gravity slides, debris flows, and confined or unconfined flashfloods, all of which are most commonly instigated by sporadic and catastrophic heavy rainfall or snowmelt. The types of processes active on a fan are dictated by precipitation characteristics, drainage basin bedrock geology, morphology and enlargement history of the drainage basin, and the effect of neighbouring environments on the fan site. Fan sediment is surficially modified under more normal conditions by secondary processes, including overland water flows, wind erosion, soil development, particle weathering, bioturbation, and groundwater movement. The fan sediment may also be faulted or tilted due to tectonic activity.

The constituent morphology of a fan is a direct result of the operative primary and secondary processes. Constituent forms include debris flow lobes and levees, incised channels, smooth surfaces, rills, and gullies. The overall fan form, or composite morphology, represents the sum of all of the constituent forms. Composite morphology is characterized by a fan-shaped planview, convex cross-profiles, and radial profiles that have either a consistent slope or down-fan decreasing slope that produces a concave-upwards geometry. Fan slopes depend upon grain size variations and the types of processes operative on fans, both of which are primarily dictated by the characteristics of the drainage basin.

Desert fans are divided into two general types. Type I fans are constructed principally of clast-rich and clast-poor cohesive debris flows and may also have an incised channel. They commonly are produced by drainage basins underlain by volcanic, clayey sedimentary, or pelitic metamorphic rocks that weather to produce significant clay. Type II fans are built mostly by fluid-gravity flows, including incised channel flows and sheetfloods, along with rock avalanches or non-cohesive debris flows. They are the more common product of drainage basins yielding little clay, such as granitic terranes. Secondary reworking of the Type I or II alluvial fans ranges from minor to extensive. A Type IA or IIA designation is given where the reworking is minor; a Type IB or IIB designation is given where the reworking of the primary processes by overland flows is extensive.

Drainage basin enlargement through time results in a predictable three-stage evolutionary scenario for alluvial fans, which follows a precursor stage. The precursor stage entails the accumulation of a talus or colluvial cone at the base of a bedrock notch. If a drainage basin becomes established by the enlargement of this notch, processes such as rock avalanches, debris flows, and gravity slides may occur in addition to rockfalls, leading to an incipient or Stage 1 alluvial fan. The ramp-like foundation upon which the more common composite fan morphologies form is produced during this stage. Debris flows and sheetflooding dominate the construction of fans during Stages 2 and 3, leading to decreased average slopes. Incised channels are not present or are very short in Stage 2 fans, whereas they are prominent and characterize Stage 3 fans. The presence of well-developed incised channels is a result of the progressive growth of the fan through lobe progradation. This overall evolutionary scenario results in fans that both lengthen and decrease in slope through time in concert with their drainage basin enlargement.

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