

LATE HOLOCENE GEOMORPHOLOGY OF THE
COLORADO RIVER IN GRAND CANYON,
GRAND CANYON NATIONAL PARK, ARIZONA

by

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*Work Done in Cooperation with
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and the National Park Service*

Topics of this Discussion

- Principal **deposits and geomorphic surfaces** of the river corridor;

Debris-flow fans, their temporal and spatial scale and long-term control of rapids and the course of the Colorado River

Terraces, and associated **alluvial deposits** of the Colorado River and their relation to debris-flow fans

- **Age and correlation** of the deposits using ^{14}C , archeology, and time-calibrated dissolution weathering of limestone clasts
- Post-dam **erosion of archeologic sites** in short tributary streams as related to baselevel

Methods

- Produce large-scale topographic maps of the river corridor, typical scale 1:2,000 with 1 meter contour interval
- Map, date, and classify the late Quaternary deposits
- Deposits were dated using archeologic remains, ^{14}C , and historic photographs

















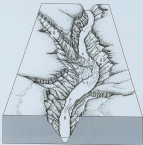




SEDIMENT TYPE AND SOURCES OF SEDIMENT
AND WATER
QUATERNARY DEPOSITS OF COLORADO RIVER
IN GRAND CANYON

Age	Type of Sediment	Sediment Source	Water Source
Holocene	Fine-grained sand	Distant, Colorado Plateau Mz	Rocky Mtns.
Pleistocene	Bouldery gravel	Local, Pz Bedrock	Local and Rocky Mtns.



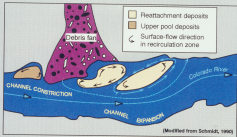


(Modified from Harlan and Rigby, 1966; Webb and others, 1988)

EXPLANATION

- | | |
|-----------------------------|--------------------|
| 1 Segmented debris fan | 4 Pool |
| 2 Debris-flow channel | 5 Tributary canyon |
| 3 Rapid | 6 Gravel bar |
| 7 "Flock garden" and riffle | |





ALLUVIAL DEPOSITION ADJACENT TO A DEBRIS FAN

PRINCIPAL LATE HOLOCENE DEPOSITS AND
GEOMORPHIC SURFACES OF THE
COLORADO RIVER CORRIDOR,
EASTERN GRAND CANYON

ALLUVIUM

Post-dam Fluvial/Channel-Side Bars

- F** Fluctuating-flow sand, 1980 to 1988
- H** High-flow sand, 1888 to 1904
- Hs** Flood sand of summer 1983, June to August 1983

Pre-dam Terraces and Terrace-like Features

- ptd** Pre-dam alluvium, 1887 to mid-1920s
- mt** Lower mesquite terrace, mid-1820s to 1888
- utd** Upper mesquite terrace, A.D. 1887 to A.D. 1400
- ap** Alluvium of Pueblo-II age, A.D. 700 to A.D. 750
- sa** Striped alluvium, -405 B.C. to A.D. 300

COLLUVIUM

Channelized Debris-flow Deposits

- cds** Younger channelized debris-flow deposits, 1884 to early 1920s
- cd** Older channelized debris-flow deposits, early 1820s to after 1900

Fan-forming Debris-flow Deposits

- fd** Younger debris-flow deposit, before 1890 to A.D. 1840-1880?
- fdi** Intermediate debris-flow deposit, before A.D. 650 to after 0 B.C.
- fdo** Older debris-flow deposit, 0 to 430 B.C.

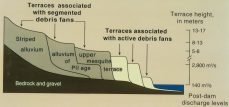
EOLIAN

Coppice Sand Dunes

- cd** Coppice sand dunes, present day to late Holocene

Sand Sheets (Falling and Climbing Sheet-like Sand Deposits)

- ss** Sheet sand, present day to late Holocene



LATE HOLOCENE TERRACES ASSOCIATED WITH DEBRIS FANS

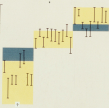
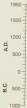
Physical stratigraphy of the alluvium



Time stratigraphy

Fan forming debris-flow deposits

Alluvium



Archaeologic chronology

PIII
PII
PI
EM III
EM II
Ar

EXPLANATION

Alluvial stratigraphy

Radiocarbon dates

- Erosion
- Deposition

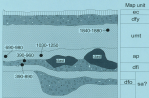
95 percent confidence interval of calibrated date











Equal horizontal and vertical scales

0 10 20 30 40 50 Centimeters

EXPLANATION



Debris-flow deposit distal facies



Eolian sand



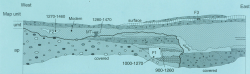
Alluvial sand



Stratigraphic position radiocarbon sample







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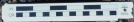






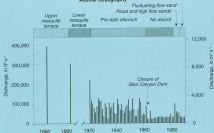








Alluvial Stratigraphy



Historic Floods and Alluvial Stratigraphy











LATE HOLOCENE TERRACES ASSOCIATED WITH DEBRIS FANS

Temporal and Spatial Scale of Debris Flows

Channelized debris flows

- Occur about every 30 years
- Most are historic, younger than about 100 years
- Relatively small, high frequency events

Fan-forming debris flows

- Occur about every 850 years
- Most are probably older than 100-800 years
- Relatively large, low frequency events

Age-Related Characteristics of Debris-flow Surfaces

dfy

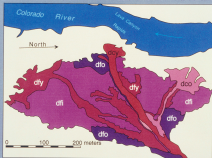
- Negligible rock varnish
- Fresh, unpitted limestone clasts

dfi

- Noticeable rock varnish on all clasts
- Split and disintegrated clasts common
- Pitted limestone clasts, pit depth 1.5 to 3.5 mm

dfc

- Well-developed rock varnish
- Split and disintegrated clasts typical
- Pitted limestone clasts, pit depth 3.5 to 10 mm



Debris Flows of the Paliades Creek Area



dry





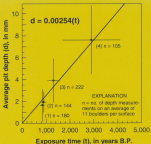
dfo



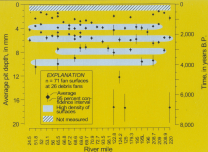








Depth of Solution Pits as a Function of Time



Age and Correlation of Debris Fan Surfaces

MODEL OF LATE HOLOCENE GEOMORPHIC DEVELOPMENT OF COLORADO RIVER IN GRAND CANYON

