OLIGOCENE-MIOCENE SEDIMENTATION RATES ON THE SW COLORADO PLATEAU: ARIDITY-DRIVEN AGGRADATION SUPPORTS A LATE NEOGENE COLORADO RIVER

Hualapai Plateau

Shivwits Plateau

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Flat Surface of Fluvial Aggradation

- Hualapai Plateau
- Basalt (Separation Hill)
- Peach Springs Canyon
- Late Miocene gravels
- Shivwits Plateau
Drainage is deflected (turns) here where opposing slopes meet

PALEOCENE-EOCENE

Shivwits Plateau

Hualapai Plateau

Dip slope drainage

Milkweed Canyon

Hindu Canyon

Shivwits scarp retreats parallel to original

Rate: ~180 m/Ma

Grand Canyon forms in similar location from similar constraints, proportional to scarp retreat distance.
1. Hualapai Plateau is an erosional “cuestaform” bench of Laramide age

2. Disrupted Laramide canyons formed local depocenters that preserve Paleogene thru Late Miocene or Early Pliocene sedimentary record

3. Eocene-Oligocene boundary (~33Ma?) is clearly visible in the stratigraphy

4. Ave. sedimentation rates appear remarkably consistent for ~15 million Ma

5. Record of post-Eocene aggradation refutes pre-Pliocene Colorado River
EOCENE – OLIGOCENE BOUNDARY IN SD BADLANDS

Chadron (Eocene)

Brule (Oligocene)
The diagram illustrates 65 million years of climate change, with a particular emphasis on the Eocene (~33 Ma) and the Oligocene (~33 Ma). The graph shows polar ocean equivalent ΔT (°C) and benthic δ18O (%) changes over millions of years ago, highlighting events such as the PETM (Paleocene-Eocene Thermal Maximum), Antarctic glaciation, and rapid glacial cycles. The data is compiled from R.A. Rohde.
Eocene-Oligocene Boundary Change (N.A.)

- **Abrupt climatic deterioration (warm wet to cool dry)**

- **N.A. Record (Protho & Berggren, 1992)**
  - 32 Ma Wooded grasslands
  - 33 Ma Dry Woodlands
  - 34 Ma Dry Forests
  - 38 Ma Moist Forests
INDIGENOUS PETRIFIED LOGS
Peach Springs Canyon
Note Preserved Bark and Growth Ring Detail
(Paleogene Music Mt. Formation)
Compare Arizona Section with Eocene in S. Dakota Badlands
Subtropical (?) Paleosol (Eocene: ~33Ma)

Buck & Doe Conglomerate (24 Ma at top)

Milkweed paleoCanyon

Limestone
MILKWEED CANYON TERTIARY SECTION

Paleocene

18.78 Ma

18.2 Ma basalt

24.12 Ma ash at Peach Sp. (U. Oligocene)

19.0 Ma basalts

Oligocene

Buck & Doe Congl

Disconformity Paleosol

Limestone

Eocene

Music Mt. Fm.

Paleocene

EOCENE AGE CONTROL?

Post-Volcanic
Late Miocene Gravels
~17.5 Ma Basalts
EARLY EOCENE (less possibly LATE PALEOCENE)
(Gastropods)
Music Mountain Fm

11 Taxa: 2 viviparids, 2 pleurocerids, 1 planorbid, 4 hydrobioids, 1 physid, 1 ellobiid

Young & Hartman, 2014
Geosphere
Long Pt. AZ
Music Mt. Fm.

Basalt 6.8 Ma
Long Pt.
Limestone
(Two Charophytes:
1 = Lower Eocene
Peckichara coronate
Flagstaff Limestone
[M. Feist]

Long Point Limestone, Arizona
(>30m. within Music Mt. arkose)
(Hill et al. Questionable U/Pb age of 65 Ma ??)
Surficial (resistant) lag gravels
V=Volcanic Clasts 163 Ma to 51 Ma

Lower Eocene

Music Mt.
Ardosic Gravel
(in situ)
Upturned West Edge of Colorado Plateau (view west)

Milkweed paleoCanyon

Tertiary Fill

Miocene basalt

Buck & Doe

Eocene
Milkweed Canyon Tertiary Fill

Upturned West Edge Colorado Plateau
Milkweed Paleocanyon Tertiary Fill

Miocene Basalt
Paleogene Fans
Eocene red beds
Oligocene
Cambrian
Buck & Doe
Milkweed Paleocanyon
Tw = Eocene Soil Horizon (Top of Eocene section) Peach Springs Canyon

Interpretative Geologic Cross Section (A-A'): Peach Springs Wash, Peach Springs Quadrangle, AZ
Vertical Exaggeration = 4.5x

See Billingsley et al., 1999, USGS Misc. Investigations Map I-2554 (Appendix) for full description of all formations and nomenclature revisions.
EOCENE

OLIGOCENE

Tertiary

Cross Section

Peach Springs 7.5 Geologic Quad

(Online: http://repository.azgs.az.gov)
Tw = Eocene Soil Horizon (Top of Eocene section)

Interpretative Geologic Cross Section (A-A'): Peach Springs Wash, Peach Springs Quadrangle, AZ
Vertical Exaggeration = 4.5x

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Peach Springs basalt (19.9 Ma)

Buck & Doe congl.

Peach Spring Tuff

(Slump Block)

OLIGOCENE

EOCENE
Basalt

© to M Limestone clasts

FLOW

Imbrication

Cross beds
GENERALIZED DIAGRAMMATIC CROSS-SECTION VIEW (ECBD) FROM FIGURE 2
Not to scale: Small features exaggerated for Clarity
Distance E-D is Approximately 21 Km

Hindu Canyon Laramide Channel
Hindu Fanglomerate

Oligocene Buck and Doe Conglomerate

kaibab, Toroweap, Coconino

Shivwits Plateau Scarp

E 1845 m

Hualapai Plateau

Kaibab, Toroweap, Coconino

Source of Distinctive Light Clasts in Hindu Fanglomerate

Supai Group

Redwall Limestone

Temple Butte

Tonto Group (Tapeats/Bright Angel/Muav)

Precambrian Basement

Shivwits Scarp Recession Presumed Equal To Distance Between Hindu and Grand Canyon
Grand Canyon

Paleogene Fanglomerate
West Edge of Colorado Plateau

Buck & Doe gravels (Oligocene)

Hindu Fanglomerate (Paleogene)

Re-exumed Relief

North Flow Directions
Upturned Edge of Plateau

Oligocene gravel source
Cambrian-Mississippian LS
GENERALIZED DIAGRAMMATIC CROSS-SECTION VIEW (ECBD) FROM FIGURE 2
Not to scale: Small features exaggerated for Clarity
Distance E-D is Approximately 21 Km

- Hindu Canyon
- Laramide Channel
- Hindu Fanglomerate
- Buck and Doe Conglomerate
- Oligocene
- Separation Hill basalt
- 1475 m
- 1128 m
- 365 m
- 1845 m

Shivwits Scarp Recession Presumed Equal To Distance Between Hindu and Grand Canyon

Projected Hindu Canyon Scarp Location (Early Paleogene?)
Source of Distinctive Light Clasts in Hindu Fanglomerate

Kaibab Toroweap Coconino
Supai Group

Redwall Limestone
Temple Butte
Tonto Group (Tapeats/Bright Angel/Muav)
Precambrian Basement

NEXT SLIDE
Sediment Accumulation Rate

Peach Springs Canyon Sections
Tw = Eocene Soil Horizon (Top of Eocene section) Peach Springs Canyon

Interpretative Geologic Cross Section (A-A'): Peach Springs Wash, Peach Springs Quadrangle, AZ
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Buck and Doe (Oligocene)

Hindu Fanglomerate (Eocene)

Peach Sp. Canyon
Oligocene Ash Bed at Peach Springs

Coyote Sp Fm (Miocene)

Buck & Doe

Top of Buck & Doe Conglomerate

Ash (24.12 Ma)
Tw = Eocene Soil Horizon (Top of Eocene section) Peach Sp. Canyon

Interpretative Geologic Cross Section (A-A'): Peach Springs Wash, Peach Springs Quadrangle, AZ
Vertical Exaggeration = 4.5x

See Billingsley et al., 1999, USGS Misc. Investigations Map I-2554 (Appendix) for full description of all formations and nomenclature revisions.
Average Sedimentation Rate
62.5 m / 8.88 Ma = 7.03 m/Ma

Peach Springs Wash
Daimond Creek Road
Basalt: 19.94 Ma

Average Sedimentation Rate

30.5 m / 4.2 Ma = 7.25 m/Ma

Peach Springs Wash
Daimond Creek Road
Tw = Eocene Soil Horizon (Top of Eocene section) **Peach Springs Canyon**

Interpretative Geologic Cross Section (A-A'): Peach Springs Wash, Peach Springs Quadrangle, AZ

Vertical Exaggeration = 4.5x

See Billingsley et al., 1999, USGS Misc. Investigations Map I-2554 (Appendix) for full description of all formations and nomenclature revisions.
Diamond Creek Road:

- Lower Section: 7.03 m/Million Years
- Upper Section: 7.25 m/Million Years

Hurricane Fault: 7.5 m/Million Years
(Ave. ≈0.8 cm/100 years) for 15 Ma
More Importantly:

Ongoing fluvial aggradation from E. Oligocene through Late Miocene or E. Pliocene Time

Refutes significant erosion of western Grand Canyon drainage prior to ~ 5-6 Ma (Pliocene)