NEW DETRITAL ZIRCON AGES AND THE PALEOGEOGRAPHY OF OLIGOCENE FLUVIAL SYSTEMS IN THE SOUTHERN GREEN RIVER BASIN, WYOMING

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PUROPOSE: **The timing and mode of the transition from an Eocene closed basin with internal drainage in the Greater Green River Basin to the present-day integrated Green River system is poorly understood. In the Eocene, Lakes Uinta and Gosiute occupied the Uinta and Greater Green River Basins, respectively. The modern Greater Green River Basin is divided into several smaller basins. The Great Divide Basin still drains internally while the Bridger, Washakie and Sand Wash basins are drained by the Little Snake, Yampa and Green. Previous interpretations of Oligocene fluvial systems include eastward drainage of the Greater Green River Basin associated with a paleo-Platte River. The purpose of this study is to reinvestigate these claims.**

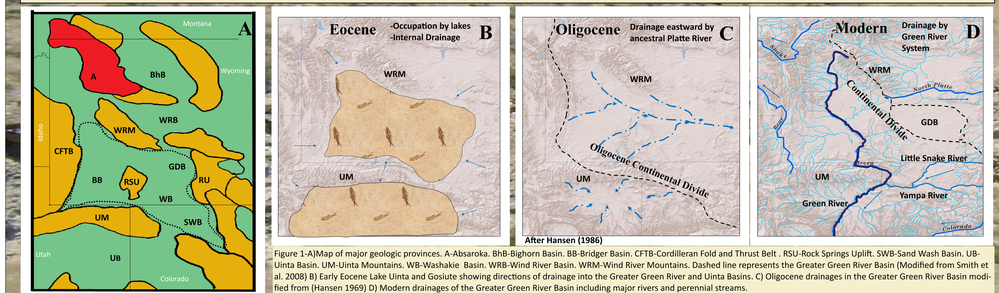
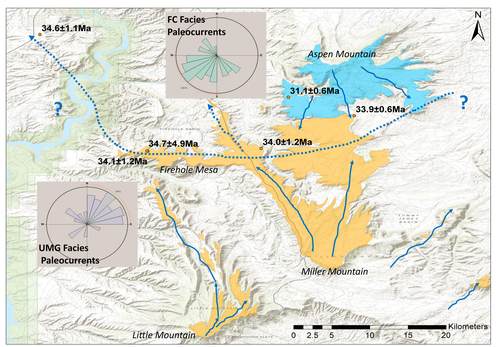


Figure 1-A)Map of major geologic provinces. A-Absaroka. BhB-Bighorn Basin. BB-Bridger Basin. CFTB-Cordilleran Fold and Thrust Belt . RSU-Rock Springs Uplift. SWB-Sand Wash Basin. UB-Uinta Basin. UM-Uinta Mountains. WB-Washakie Basin. WRB-Wind River Basin. WRM-Wind River Mountains. Dashed line represents the Greater Green River Basin (Modified from Smith et al. 2008) B) Early Eocene Lake Uinta and Gosiute showing directions of drainage into the Greater Green River and Uinta Basins. C) Oligocene drainages in the Greater Green River Basin modified from (Hansen 1969) D) Modern drainages of the Greater Green River Basin including major rivers and perennial streams.

Bishop Conglomerate Lithofaces and Oligocene Fluvial System Interpretations



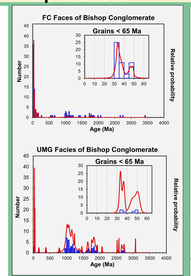
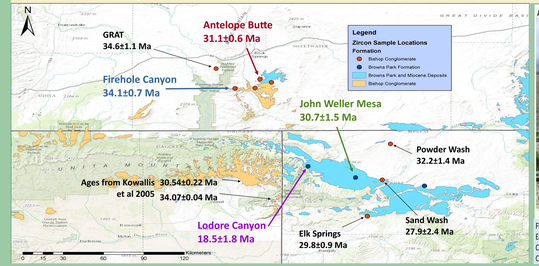


Figure 2) left: Minimum Depositional Ages from Bishop Conglomerate near Aspen Mountain and Firehole Mesa
Figure 3) above: Representative detrital zircon spectra of UMG facies and FC facies of Bishop Conglomerate
Figure 4) right: Photographs of UMG and FC facies of Bishop Conglomerate.

BISHOP CONGLOMERATE LITHOFACIES

Two facies of the Bishop Conglomerate are present at locations near Flaming Gorge Reservoir and Aspen Mountain which differ in three major categories. **1) Clast Types:** The facies traditionally identified with the Bishop Conglomerate (UMG facies) consist of poorly sorted, subangular to subrounded sandy gravels of predominantly red Proterozoic quartzite, gray Paleozoic limestone clasts and beige Mesozoic sandstone clasts. These gravels interfinger with a second unit of fluvial gravels (FC facies) that are markedly different from the UMG facies and consist of rounded pebble- to cobble-sized gravel that is dominated by non-red quartzite clasts and a minor component volcanic rocks most likely reworked from Tertiary strata containing clasts derived from the Absaroka Mountains in northern Wyoming. The FC facies is devoid of red quartzites except in areas where mixing with the UMG facies occurs. **2) Paleocurrents:** Paleocurrents from the UMG facies suggest that Bishop rivers drained the Uinta Mountains and flowed north towards the Greater Green River Basin. The FC facies has paleocurrents to the west and southwest and was probably an axial river that was fed by Bishop streams. **3) Detrital Zircon Spectra:** Although detrital zircon spectra for the UMG and FC facies of the Bishop Conglomerate exhibit the same age populations there are differences in the dominant signatures. The UMG facies is dominated by ages which can be attributed to bedrock units in the Uinta Mountains (>760 Ma from Dehler et al. 2010). In contrast, the FC facies is dominated by young grains (<100 Ma).

Detrital Zircon Analysis



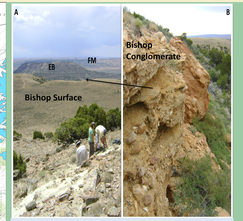
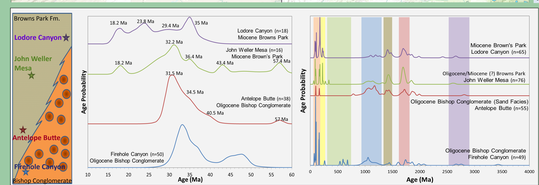


Figure 5) Stratigraphic relationships. A. Sitting on Antelope Butte. In the distance is Earnest Butte (EB) and farther is Firehole Mesa (FM) both are capped with Bishop Conglomerate and lie below Antelope Butte in elevation. B. Exposure of Bishop Conglomerate from the unit below Antelope Butte.



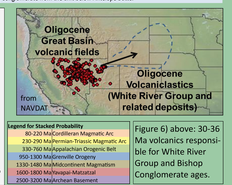


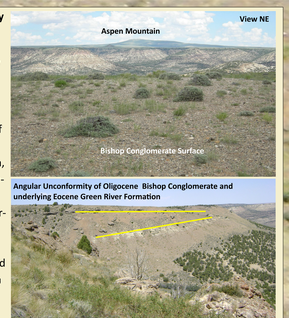
Figure 6) above: 30-36 Ma volcanics responsible for White River Group and Bishop Conglomerate ages.

U-Pb DETRITAL ZIRCON ANALYSIS OF THE BISHOP CONGLOMERATE AND RELATED DEPOSITS

New U-Pb detrital zircon data provide the first direct estimate of the Bishop Conglomerate and related deposits along the north flank of the Uinta Mountains. The Bishop Conglomerate samples from Firehole Canyon/Aspen Mountain produced a maximum depositional age that ranges from 33.9 ± 0.6 Ma to 34.7 ± 4.9 Ma. Overlying tuffaceous sandstones at Antelope Butte returned a maximum depositional age of 31.1 ± 0.6 Ma which provides a minimum age for the Bishop Conglomerate. Stratigraphically younger samples of the Browns Park Formation (John Weller Mesa 30.7 ± 1.5 Ma, a single grain of 18.8 Ma, and 18.5 ± 1.8 Ma at Lodore Canyon). These younger maximum depositional ages are consistent with their younger stratigraphic position. Geochemical analyses suggest that much of the volcaniclastic material in Bishop Conglomerate and Browns Park Fm. deposits were sourced by Great Basin calderas (Luft, 1985; Kowallis et al., 2005). This semi-continuous source of volcanic ash, which contained zircon grains, coupled with westerly winds, would have permitted a relatively constant influx of zircon-bearing ash into the Green River Basin where it was incorporated into Bishop Conglomerate rivers throughout the Oligocene, and Browns Park fluvial-lacustrine environments in the Miocene. This constant influx of Oligocene-Miocene ash along with progressively younger maximum depositional ages of successively younger stratigraphic units indicates that the maximum depositional ages are true depositional ages for the Bishop Conglomerate and lower Browns Park Formation.

Bishop Conglomerate as a Possible Syntectonic Deposit Recording Regional Uplift in the Rocky Mt Region

Previous workers have interpreted the Bishop Conglomerate as an Oligocene pediment that formed along the flanks of the Uinta Mountains in response to a change towards increasing aridity at the Eocene-Oligocene transition (Bradley, 1936; Hansen, 1986). An alternate interpretation, however, is that the Bishop Conglomerate formed in response to regional uplift of southwestern Wyoming, and perhaps the entire Rocky Mt region, in the early Oligocene. This suggestion is supported by the discontinuous distribution of Bishop Conglomerate outcrops along the north flank of the Uinta Mountains, which could represent remnants of paleovalleys cut into Tertiary strata and floored by Bishop Conglomerate, rather than a laterally continuous pediment complex. In addition, the Bishop Conglomerate truncates Laramide-basin-fill deposits regardless of age or structural relations. This observation suggests that the Bishop Conglomerate accumulated in response to a regional lowering of base level within the Green River Basin, which prior to the Oligocene, had undergone long-term subsidence and basin filling. Additionally, the maximum depositional ages of the Bishop Conglomerate are slightly younger (~30 Ma) along the east flank of the Uinta Mountains compared to the sites along the north flank of the Uinta Mountains (~35 Ma). This difference could reflect the onset of collapse of the eastern Uinta Mountains in the Oligocene (Hansen, 1986) and a shift in the locus of Bishop Conglomerate sedimentation in response to this collapse.



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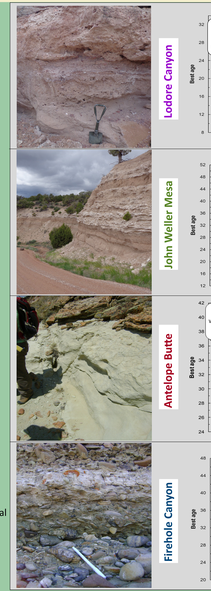

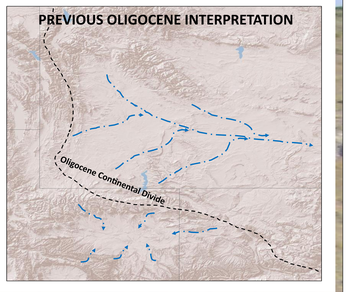

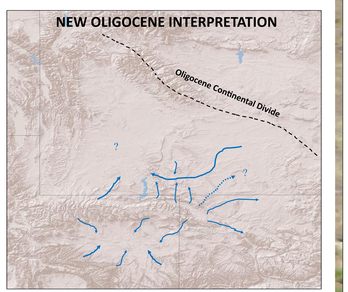

CONCLUSIONS

-U-Pb detrital zircon analysis can be used to reconstruct the paleogeography of ancient river systems

Differences in zircon spectra of two facies of the Oligocene Bishop Conglomerate illustrate the following 1) a west-flowing axial river system existed to the north of the Uinta Mountains and discharged into possible remains of Eocene Lake Gosiute, and 2) the Uinta Mountains were drained by northward flowing streams. The axial fluvial system most likely drained the Oligocene Continental Divide. The presence of Absaroka derived volcanic clasts, quartzites and chert pebbles in the axial system indicate a reworking of Tertiary and Mesozoic strata to the east where Tertiary deposits such as the Washakie Formation contain these clast types.

-Detrital zircon results highlight the importance of windblown sediment inputs (i.e. zircon-bearing volcanic ash) for interpreting the U-Pb detrital zircon spectra of fluvial deposits, and indicate that in certain situations, maximum depositional ages can reflect true depositional ages.

U-Pb detrital zircon data for the Bishop Conglomerate and Browns Park Formation samples provide maximum depositional ages that are likely the actual depositional ages of the deposits. This interpretation is supported by 1) maximum depositional ages of tuffaceous deposits that systematically decrease at successively younger stratigraphic levels, and 2) the constant input of Oligocene volcanic ash into the Greater Green River Basin from sources in the Great Basin. This interpretation is further supported by radiometric ages for distinct ash layers of the Bishop Conglomerate in the Uinta Basin (30-34 Ma; Kowallis et al., 2005) and maximum depositional ages of U-Pb detrital zircon analyses from the Greater Green River Basin whish show ages ~28-35 Ma for the Bishop Conglomerate.

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