Characterization of Quaternary alluvial terraces in the Buffalo National River valley, Arkansas

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Conclusions

- There has been no significant change in sediment size or transport capacity over the period of alluvial terrace formation.
- The spatial pattern of terraces preserved in the BNR is complex because of factors and processes of terrace formation and preservation including channel reworking of floodplain sediments, episodic channel incision and aggradation, and erosion and re-working of terrace sediments subsequent to their formation.

Introduction

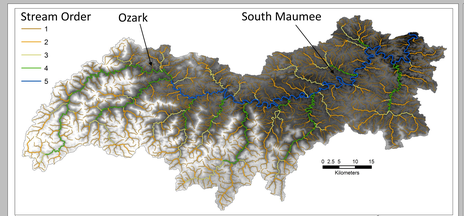
Despite its topographic prominence in the mid-continent of North America, there is no definitive geomorphic history of the Ozark Plateaus region.

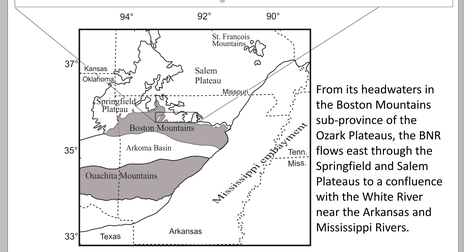
The Buffalo National River (BNR) in northern Arkansas has the highest topographic relief in the Ozark Plateaus, is un-dammed over its 214 km (134 mi) length.

The channel is an ingrown meandering bedrock stream with non-linear variation in valley and channel width owing to heterogeneous lithology and to significant influence of karst processes on valley evolution.

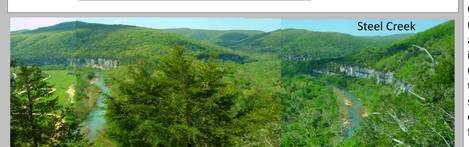
The BNR valley is underlain by Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary strata that are subject to both physical and chemical (karst) erosion.

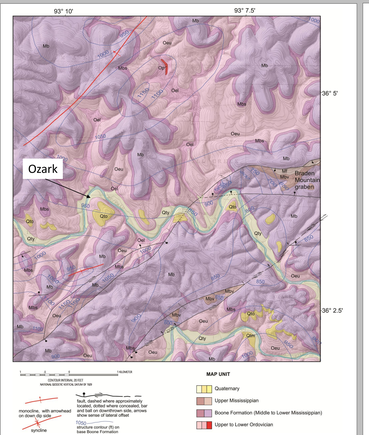
As a first step toward quantifying the rates of landscape evolution of the BNR valley, we have characterized the alluvial terraces and sediments archived therein at two pilot sites: Ozark and S. Maumee.





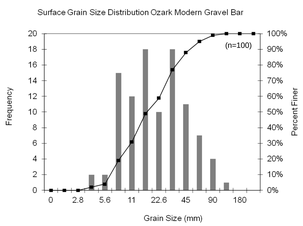
From its headwaters in the Boston Mountains sub-province of the Ozark Plateaus, the BNR flows east through the Springfield and Salem Plateaus to a confluence with the White River near the Arkansas and Mississippi Rivers.

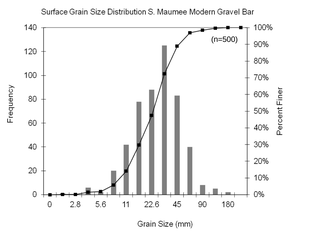


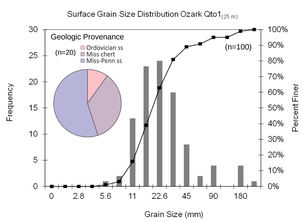


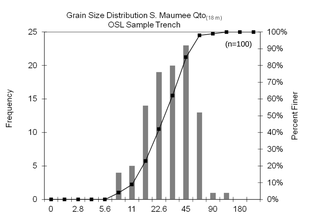
Geologic map modified from the eastern Jasper quadrangle (Hudson and others, 2001) and western Hasty quadrangle (Hudson and Murray, 2004) with location of Ozark site. Geologic mapping indicates two units at the site: younger sediment (Qty) and older Quaternary sediment preserved in the Qto terrace at 43 m above the channel elevation. Subsequent field observations indicate that several smaller sub-units exist, likely resulting from a combination of redistribution of sediment through erosion and episodic floodplain construction, channel incision and aggradation.

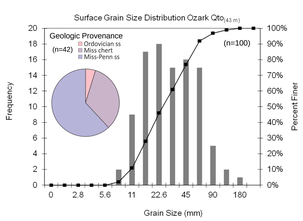
Grain Size Distributions of Modern Gravel Bars and Terraces at Ozark and S. Maumee

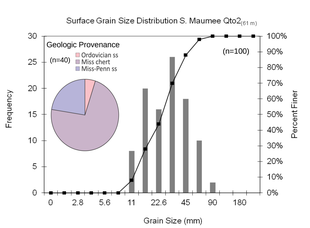








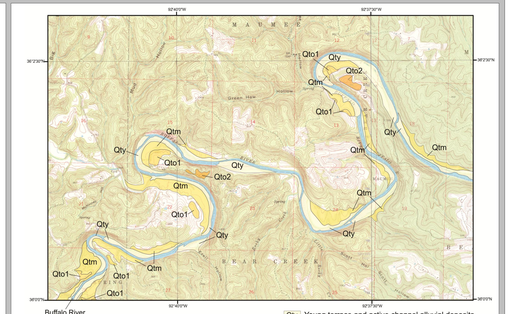




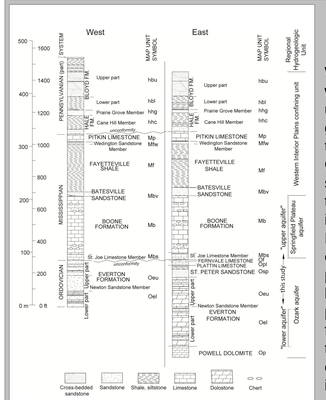
Grain size distributions shown above were measured on the modern gravel bar, and on two terraces above the modern channel elevation at Ozark and South Maumee. Terraces are present at Ozark at 25 and 43 m above the elevation of the modern channel and at 18 and 61 m above the channel elevation at S. Maumee (see also Channel and Terrace Profiles at bottom left).

Terrace sediments were measured where clasts are exposed at the ground surface, in road cuts, and in stream cuts. At South Maumee, the grain size was measured in a sample trench dug for OSL sampling. Comparisons of grain size distributions between the modern gravel bars and the terrace sediments show no significant variation, suggesting that the sediment transport capacity has remained fairly constant over the time of river incision.

For a subset of clasts from some terraces, the geologic provenance was determined and weathering rind thickness was measured (see pie graph insets above). A mixed geologic provenance of coarse sediments (5-128 mm) on the two higher terraces at Ozark (25 and 43 m) suggests that the clasts are not locally derived and have been transported downstream. (Subscript number in parenthesis indicates the height above channel elevation.)



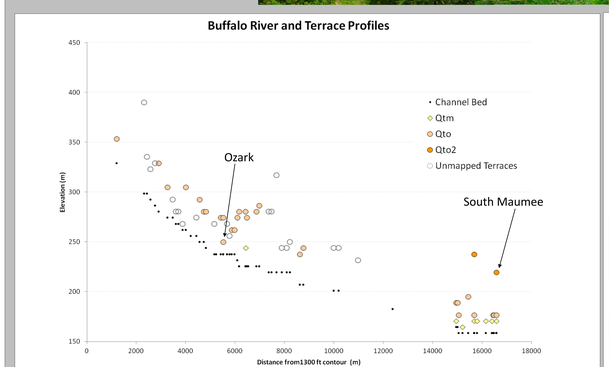
Quaternary geologic mapping adapted from Turner and Hudson (2010) over topographic base from the Maumee and Cozahome USGS 7.5-minute quadrangles. At South Maumee, a sequence of 4 terraces are preserved at 8, 12, 18, and 61 m above the elevation of the modern channel (158 m above msl).



Representative stratigraphic columns for Paleozoic rocks for the eastern and western parts of the BNR catchment. Regional hydrogeologic units follow Adamski et al. (1995). FM.–Formation

Future work

We plan to extend this work in the future by using a variety of geochronologic techniques, including OSL dating of terrace sediments, to define the timing and rate of incision of the Buffalo National River. The extension of this preliminary work will test hypotheses about the processes and rates of floodplain construction, terrace formation, and channel incision in this ingrown meandering, gravel mantled, bedrock channel and serve as a prototype for fluvial landscape evolution in the Ozark Plateaus Physiographic Province.



The lowest elevation of mapped Qtm, Qto, and Qto2 terraces was measured on 1:24k scale geologic maps.

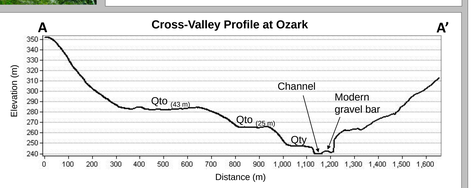
Criteria for identifying likely terrace locations that are yet unmapped include terrace units observed in the field and relatively large flat areas on the inside of meander bends with large amplitude.

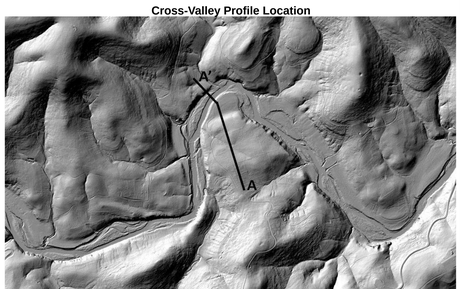
At terrace locations, the elevation of the channel was noted to create the channel long profile.

Because of the large variation in terrace elevations, interpretations of past channel long profiles are yet un-satisfactory.

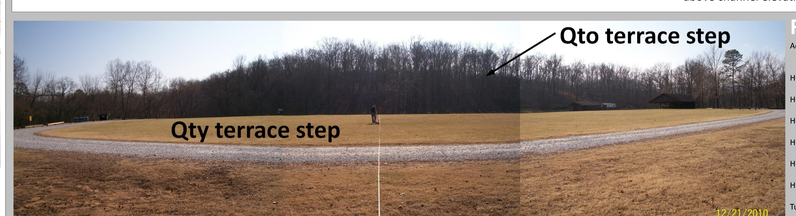
There are several interacting processes and factors at play in terrace formation in the Buffalo National River and the Ozarks region that may result in this complex spatial pattern of terrace preservation including:

- Local autogenic processes related to incision and the formation of bedrock meanders in an ingrown meandering system
- Response to base level change in a catchment with heterogeneous lithology
- Influence of karst processes on channel base level response and catchment evolution





The valley cross section at Ozark measured from LiDAR data shows multiple steps within the Qto terrace. The lower image is a hillshade derived from LiDAR data at Ozark and indicates the location of the cross valley profile. The Qty and Qto(25m) terraces are shown in the photo at right. (The subscript number in parentheses indicates height above the channel elevation).



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