High channel mobility sequesters coarse sediment in floodplain deposits

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# Abstract

# Introduction

The Paleocene Eocene Thermal Maximum (PETM) is the most severe climate perturbation known in the Cenozoic Era. The PETM is associated with altered hydrological cycling and precipitation extremes driven by rapid warming and accumulation of atmospheric carbon. As such, it serves as the best-known, and best-studied past analogue for contemporary anthropogenic climate warming. By studying paleo-environmental change during the PETM, we can better understand the mechanisms by which landscapes respond to rapid climate warming. Insights derived from the paleoenvironmental record of the PETM can be leveraged to guide and improve climate models and long-term hazard forecasts.

The stratigraphic record of the PETM generally indicates that altered hydrological cycling and temperature patterns impacted landscapes and sedimentary systems. Associated most often with a distinct, abrupt shift in sedimentary facies, the PETM has been identified to coincide with lithostratigraphic contacts globally. For example, the PETM is connected to increased terrestrial fine-grained flux to marginal marine environments , coarsening and braiding of fluvial environments , and

Overall, these globally-distributed observations suggest that terrestrial sediment transport systems responded to accommodate altered hydrological cycling. However, mechanisms invoked for this response are ambiguous or inconclusive. Generally, previous studies suggest that increased discharges , transient increases in sediment flux , or fluvial steepening are responsible for changes in fluvial style and transport.

However, it is not well understood whether increased fluxes of sediment are required to enrich the floodplain in sand. Rather, channel mobility alone could be the culprit.

Turn to a site which experienced a fluvial response to altered hydrological cycling, and evaluate specific changes in paleohydrology to develop a model for how changes in hydrology can alter sedimentology.

Will address the following hypotheses:

River channel geometries and kinematics respond to altered hydrology during the PETM via deepening and greater mobility.

Higher channel mobility drives sand enrichment in floodplain deposits, and depletes the floodplain of mud, which is exported to downstream basins.

# Study Site and Methods

Brief summary of Piceance Basin stratigraphy

It’s a good site for our study because it experienced:

No documented changes in subsidence history during this interval

No changes in sediment provenance

No evidence for tectonically-driven increases in sediment flux

Paleoshoreline at a great distance (1000s of kilometers)

Paleohydraulic estimates

Bar clinoform thicknesses

Grain size

Reworking index

Ratio of partially preserved barforms to fully preserved barforms

Indicates higher relative revisitation rate of channels

Model for sand enrichment via lateral migration\*

Box model approach, where sand fraction in reservoirs is a function of channel kinematics.

Will likely include feedbacks where enrichment in sand depends on sand fraction.

# Results and Interpretations

No change in paleogeometries Partially a function of poor resolution Indicate that channel geometries likely did not change by more than a factor of 10 This implies that rivers did not necessarily carry a higher discharge or sediment flux More floodplain reworking during PETM interval Shown through increased cross-cutting of bar deposits Also through changes in avulsion style (hope to add this if we bring in Liz) Probably due to flashier hydrograph Implies faster lateral migration rates and avulsion rates. This process could explain coarsening of deposits without invoking higher fluxes. Increased sand fraction of fluvial deposits during PETM Related to avulsion and lateral migration “combing” or “distilling” of the floodplain, excavating fine material, re-exposing it transport, and distributing sand parcels across the floodplain. An individual parcel of floodplain material therefore had a higher likelihood of being reworked, which likely increased the exposure frequency of floodplain organic matter to oxidation The converse of this assertion is sand is preferentially bypassed during Atwell and Shire time, likely due to stable channels that act as conduits for coarse sediment.

# Conclusions and Implications

Higher paleodischarges and sediment fluxes have been invoked to explain sedimentological differences in the Piceance and other basin, but we do not find this to be supported by paleohydraulics.

Instead, the same effect can be achieved by varying only the lateral migration rate of the channel, and partitioning more channel sediment to deposits.

Before the PETM, the initial hydrological regime favored meandering channels that seldom avulsed and laterally migrated through bar accretion.

As a result of the PETM, an altered hydrograph increased channel activity, driving more channel sediment to be deposited in floodplains. This could be because of: Destabilized banks (less vegetation) Increased frequency of avulsion triggers

Therefore, the sedimentological signature of the PETM can be generated with a simple increase in channel mobility.

Implications for carbon cycling

Implications for basin analysis and reservoir connectivity.

Implications for future environmental change