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TECTONIC INFLUENCES ON SPECIES RICHNESS OF MAMMALS IN THE MIDDLE MIOCENE DOVE SPRING FORMATION, CALIFORNIA



INTRODUCTION

The Middle Miocene (12.5 - 8.0 Ma) Dove Spring Formation (El Paso Basin, northwestern Mojave region) is the source for one of the most complete Clarendonian faunal assemblages in North America. The geographic distribution of mammals is affected by tectonic processes that alter the topographic complexity of regions, creating:

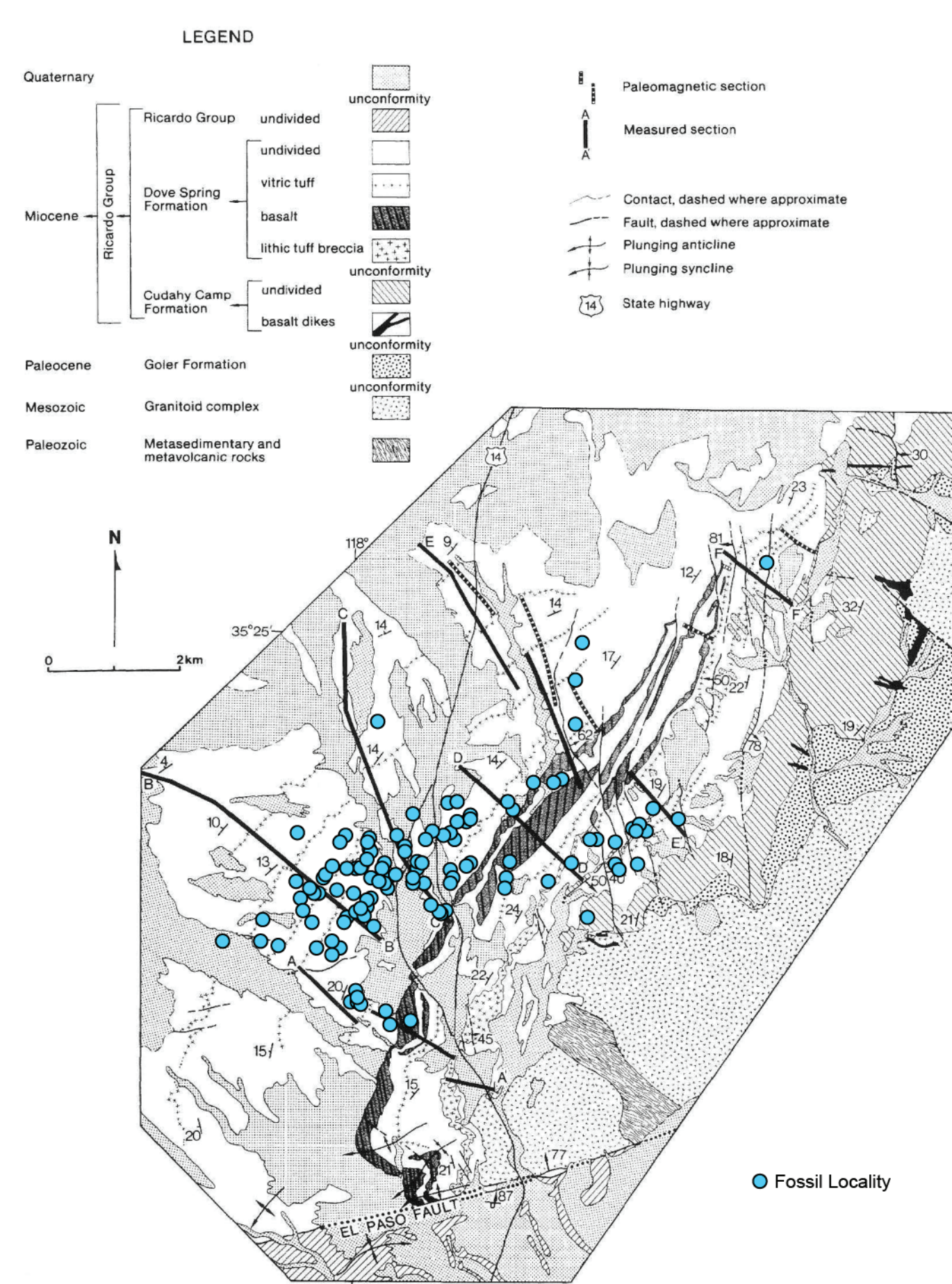
- Barriers to dispersal
- New habitats
- Climate zonation

Research Goals

To investigate changes in the mammalian species richness of the Dove Spring Formation as they relate to changes in:

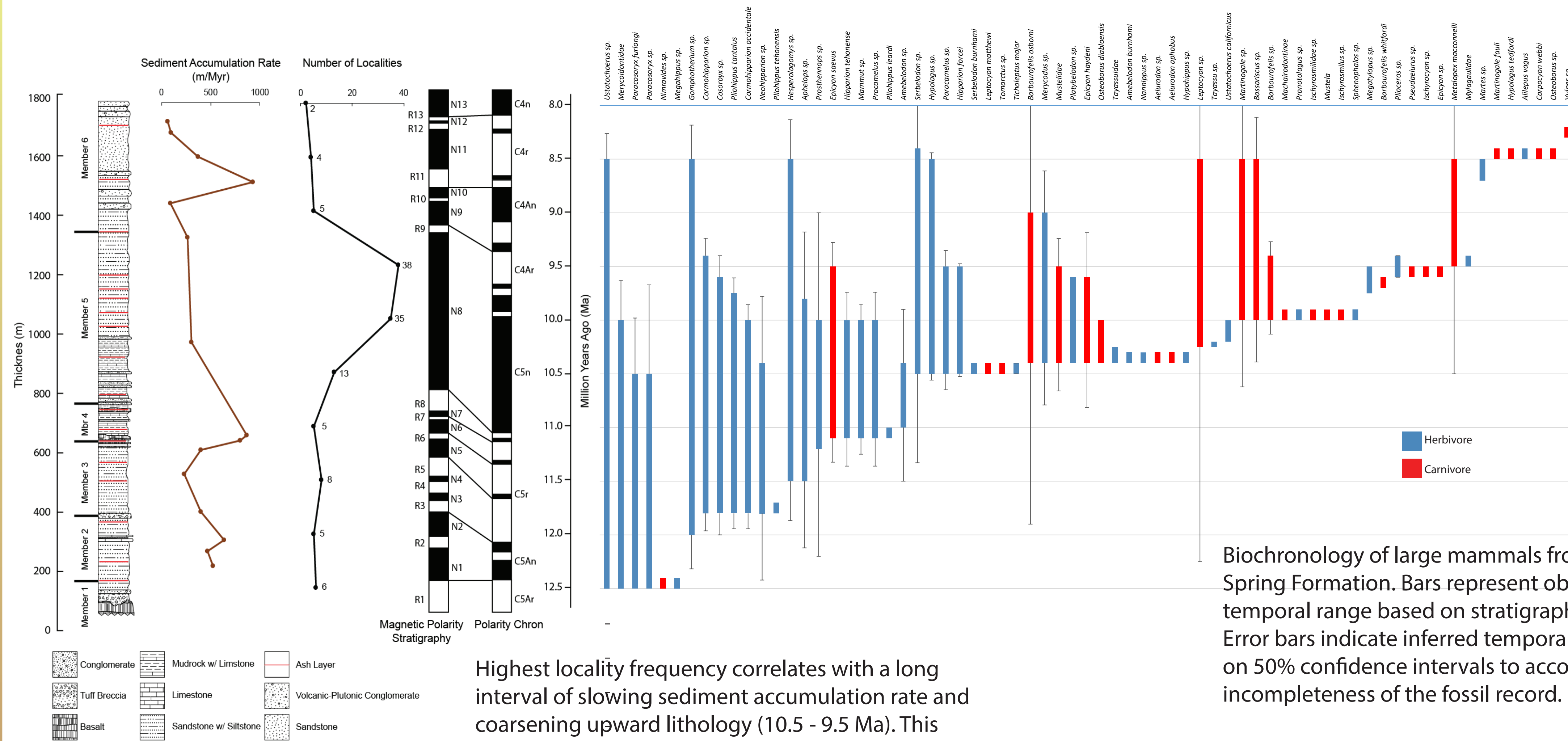
- Lithology
- Depositional environment
- Sediment accumulation rate
- Locality frequency

FOSSIL LOCALITIES



I examined 827 specimens from 162 fossil localities, representing 11% of specimens and 20% of localities from the Dove Spring Formation. New transects are marked in red. Map modified from Whistler et al. (2009)

LOCALITY FREQUENCY AND SPECIES RICHNESS

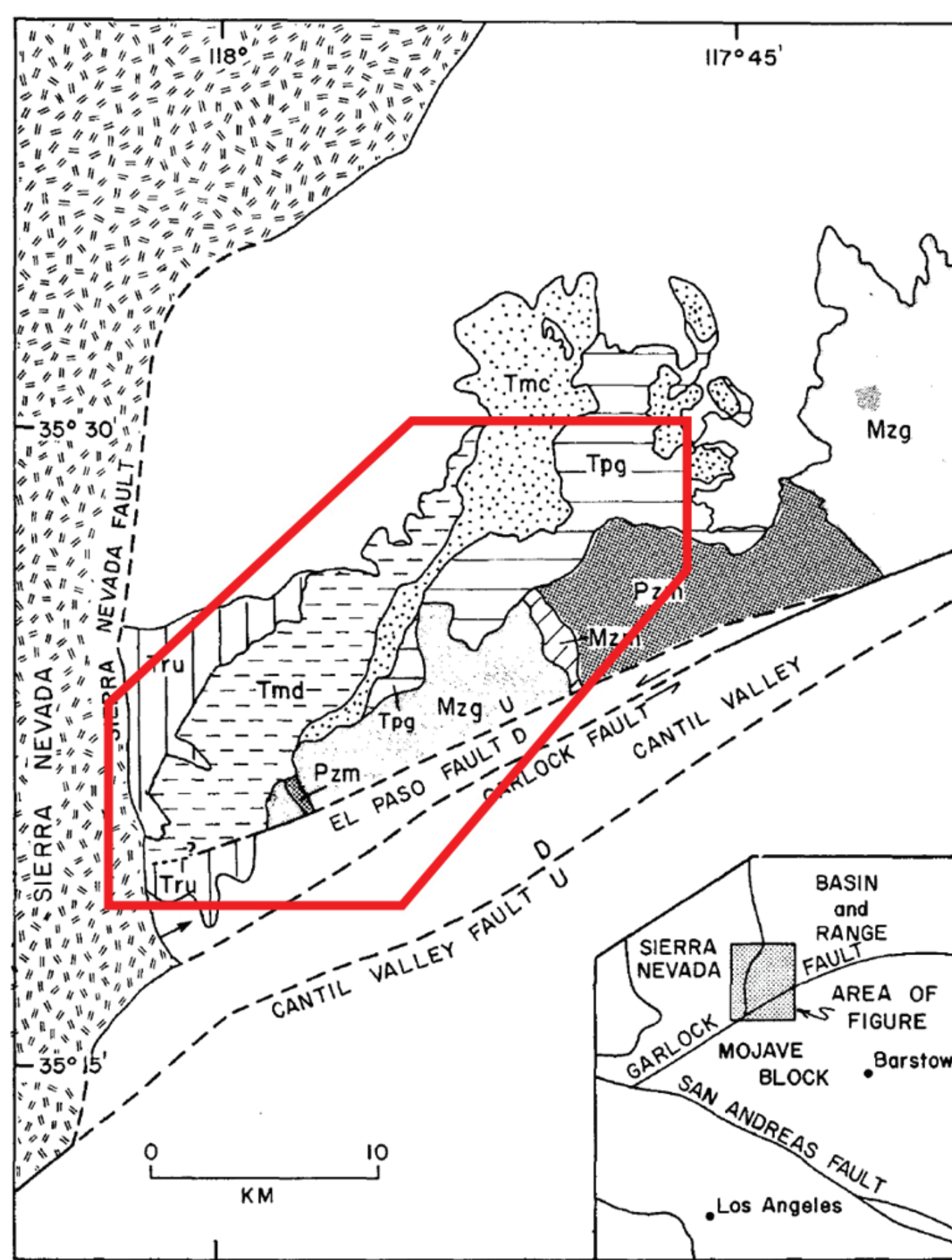


Highest locality frequency correlates with a long interval of slowing sediment accumulation rate and coarsening upward lithology (10.5 - 9.5 Ma). This corresponds to initiation of sinistral movement on the Garlock and El Paso faults. Counterclockwise rotation of the El Paso Basin led to the activation of a new sediment source area near 9.0 Ma.

Biochronology of large mammals from the Dove Spring Formation. Bars represent observed temporal range based on stratigraphic position. Error bars indicate inferred temporal range based on 50% confidence intervals to account for incompleteness of the fossil record.

Locality frequency increases at 10.5 Ma, along with significantly more singletons and carnivores, suggesting taphonomic conditions during this interval were excellent to capture rare taxa.

EL PASO BASIN



El Paso Basin is located in the northwestern Mojave region. The western boundary is a dip-slip splay of the Garlock transform fault that initiated between 11.0 to 10.0 Ma. Basin fill is primarily sourced from mountains to the south and west. Map modified from Loomis & Burbank (1988).

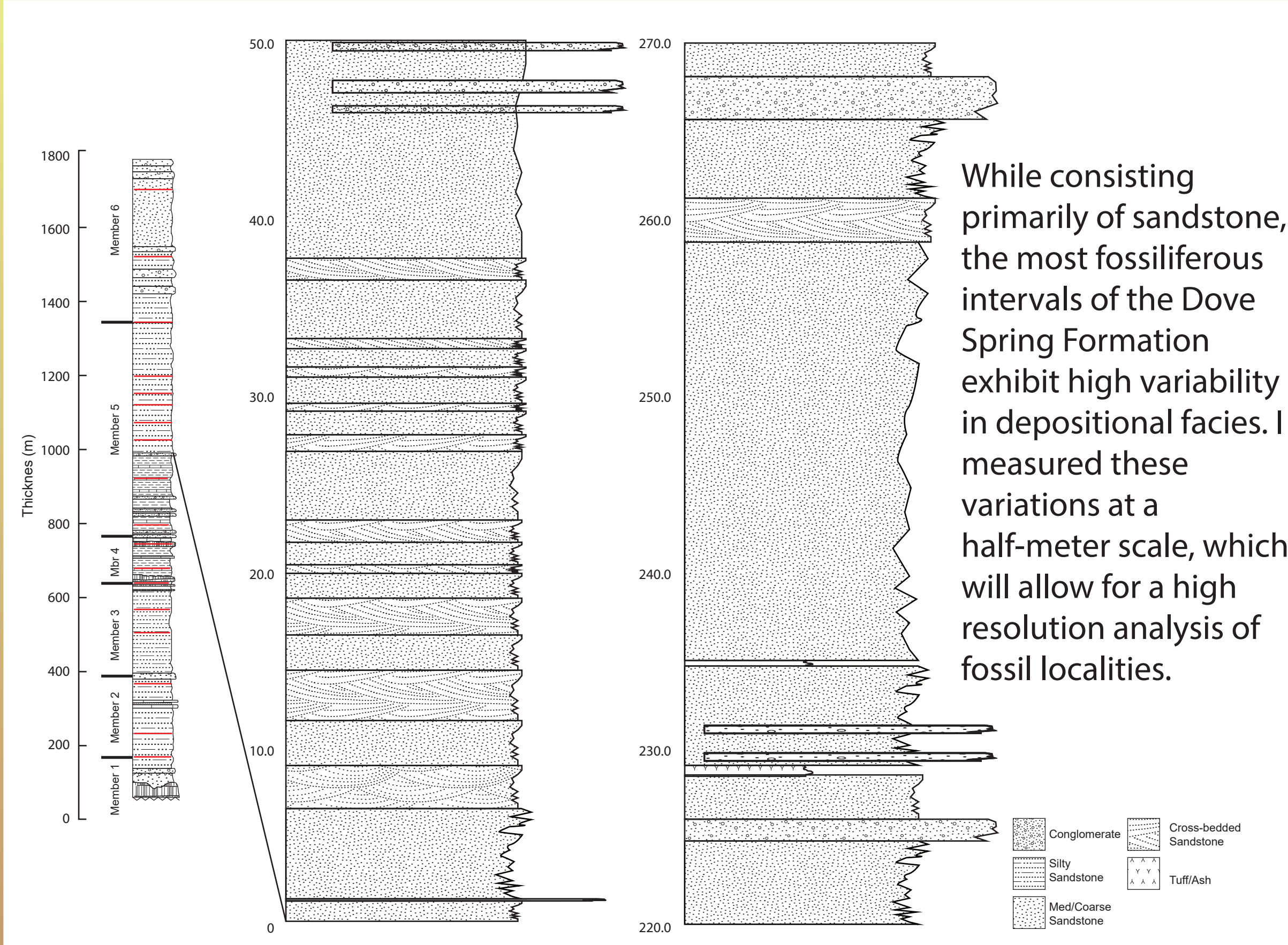
PREDICTIONS

I selected large mammals as my focus due to their high diversity and abundance in the Dove Spring record. Large mammals are capable of travelling long distances, allowing for regional correlation of stratigraphic/temporal ranges throughout the Basin and Range Province.

Predictions:

- High sediment accumulation rate of fine-grained sediments
 - = High locality frequency and species richness
- Low sediment accumulation rate of coarse sediments
 - = Low locality frequency and species richness
- Depositional facies will record a series of changing environments that contain a succession of large mammals.
 - =Changes in depositional environment will coincide with the appearance or disappearance of mammal species.

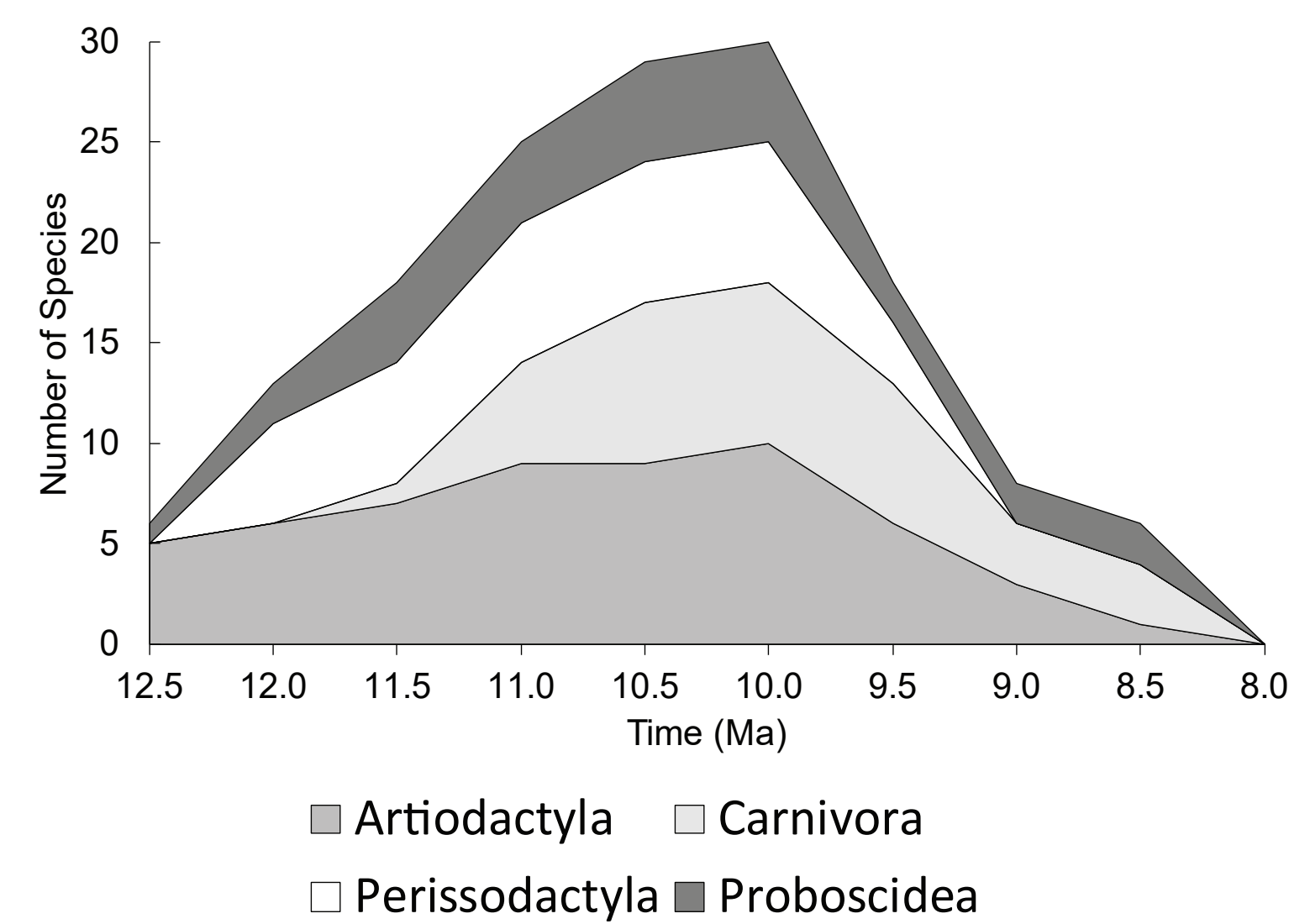
VARIABILITY WITHIN SECTION



While consisting primarily of sandstone, the most fossiliferous intervals of the Dove Spring Formation exhibit high variability in depositional facies. I measured these variations at a half-meter scale, which will allow for a high resolution analysis of fossil localities.

SPECIES RICHNESS

Species richness of large mammals from the Dove Spring Formation based on temporal ranges with 50% confidence intervals.



The rapid disappearance of perissodactyls prior to other species suggests a potential change in environmental conditions. The abundance of carnivores and singletons during this same interval suggests that taphonomic conditions captured a representative sample of large mammals.

FAUNAL TRENDS



Middle portion of Dove Spring Formation, above basalts.



Massive pink tuff "breccia" in lower Dove Spring Formation.

CONCLUSIONS

- Peaks in sediment accumulation rate do not correlate with locality frequency
- Species richness of large mammals follows locality frequency, suggesting preservational or sampling effects
- However - local disappearance by 9.0 Ma of perissodactyls suggests a change in environmental conditions
- Left-shear movement on the Garlock fault and extension along the El Paso Fault coincides with a decline in species richness near 10.0 Ma.
- The upper Dove Spring Formation is predominantly sandstone, but is highly variable, indicating changes in depositional environments.

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REFERENCES

- Badgley, C., 2010, Tectonics, topography, and mammalian diversity. Ecography.
- Loomis & Burbank, 1988, The stratigraphic evolution of the El Paso basin, southern California: Implications for the Miocene development of the Garlock fault and uplift of the Sierra Nevada. GSA Bulletin
- Whistler et al., 2009, Revised Miocene biostratigraphy and biochronology of the Dove Spring Formation, Mojave Desert, California. Museum of Northern Arizona Bulletin.

FUTURE WORK

I will characterize the series of depositional facies represented by the Dove Spring sediments. With my newly collected half-meter scale stratigraphy, I will place the timing of appearances and extinctions into a high-resolution chronology. I plan to characterize the paleoclimate using stable isotopes of soil carbonates and mammal tooth enamel. A major component of this phase will be to determine whether the basin's vegetation was dominated by open, warm-season grasses, or closed canopy plants. This will provide further evidence for biotic response to environmental factors.