present. LiDAR data sets are becoming increasingly available for download from government agencies, with resolution often on the order of one meter. We examined LiDAR data sets from several areas in New York, Pennsylvania, and Connecticut, converting them to slope maps in ArcGIS. Areas of high slope should include rock outcrops, which often have higher slopes than other surfaces in the landscape.

Many road cuts and stream exposures were identifiable in slope maps, even under fairly dense tree cover. Other high-slope features include man-made structures like retaining walls and dams, but given high enough quality LiDAR, these appeared more regular than most outcrops. Not surprisingly, some outcrops could not be distinguished in slope maps. Some were too small to be evident given the resolution of the data, and some were simply not high-slope features (e.g., flat or sloping bedding plane exposures; strata exposed in stream beds but not along banks). In some cases, the stratigraphic position of an outcrop could be inferred from the topography of the landscape surrounding the outcrop. For example, the alternation sandstone- and mudstone-dominated formations/members can be evident in the alternation of zones of higher and lower slopes. This information can supplement geologic maps in locating outcrops ahead of time that expose a desired stratigraphic interval.

PRESERVING FOSSIL PRINTS IN AN EPHEMERAL LANDSCAPE

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The Tularosa Basin of New Mexico has provided a snap shot in time of incredible ichnofossils. Beginning in 1931, with what was first thought to be footprints of a "big-foot" and later identified as those of a giant ground sloth. A large diversity of Late Pleistocene soft sediment gypsum ichnofossils have been found in the lake beds that created White Sands National Monument (WHSA) and the world's largest gypsum dune field. In recent years, thousands of ichnofossils of extinct Rancholabrean fauna have been found, including prints of Proboscidea (mammoth), Pilosa (ground sloth), Carnivora (canid and felid), and Artiodactyla (bovid and camelid) as well as humans. What sets the prints within the boundary of White Sands National Monument (WHSA) apart is not only the sheer number of prints, with densities often >10 per square meter, and but the spatial area over which they are distributed. At WHSA individual humans and animals can be tracked over kilometers and seen in many places interacting. The prints have been referred to as ghost prints because they can be seen only under specific moisture conditions and once exposed they are often destroyed by the elements in just a few years. It is the mission of the National Park Service to preserve cultural and natural resources for future generations, but how can this be done with resources that are so ephemeral and so elusive? This talk will focus on the work, collaboration, and techniques that have been develop to locate, preserve the prints (through documentation and data collection), persevering the impossible, capturing this incredible story for future generations.

BRACHIOPOD PHYLOGENOMICS: IMPLICATIONS FOR THE EVOLUTIONARY HISTORY OF BIOMINERALIZATION AND THE CAMBRIAN EXPLOSION

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Within Lophotrochozoa, brachiopods and allied clades are among the first biomineralized Cambrian metazoans to appear and represent a major component of the oldest known fossil record of animals. While the brachiopod fossil record is ultimately the key to determining character homology and polarity during the evolution of the brachiopod body plan, reading this record has been clouded by disagreement about relationships among the crown clades. Specifically, the monophyly of brachiopods with respect to phoronids, and the relationships of the calcitic to phosphatic-shelled brachiopods. Much of this phylogenetic uncertainty stems from difficulties in rooting the brachiopods and their sister groups within Lophotrochozoa.

Consequently, we have conducted the first extensive phylogenomic investigation with broad taxon sampling of Brachiopoda/Phoronida with analyses that combine novel sequence data with all publicly available brachiopod and phoronid transcriptomes in addition to a broad range of protostome outgroups.

Analyses were run under best fitting evolutionary models (LG) utilizing both published lophotrochozoan ortholog sets and novel brachiozoa specific orthologs. Preliminary results (of a ~20k amino acid partitioned alignment with 75% occupancy) strongly (>99% bootstrap) support a monophyletic Brachiopoda with Phoronida as sister group within Lophotrochozoa. High bootstrap support (>90% bootstrap) is also found for Inarticulata under Maximum Likelihood. Preliminary Bayesian results are consistent with this topology.

In addition, we are also generating a set of best-practice molecular clock calibration points. This encompasses *a priori* evaluation of relevant paleontological, phylogenetic, stratigraphic and geochronological data, all of which are critical to establishing effective and well supported time calibration points.

This combined dataset will allow us to test, under a Bayesian analytical framework, the hypothesis that the Cambrian explosion was a synchronous period of rapid molecular evolution, in addition to the rapid appearance of high-level morphological disparity. Testing the relationship between molecular and morphological evolution in the Cambrian has important implications for arbitrating between potential driving mechanisms including ecological opportunism, body size evolution, and changes to gene regulation, also for understanding how evolutionary rates vary across geologic and clade history. Combining fossil and molecular data in this integrated framework provides novel insight into brachiopod biomineralization and evolutionary patterns during the Cambrian radiation. With an excellent fossil record and well-resolved phylogeny, brachiopods also provide a rich empirical dataset to test for potentially significant 'push of the past' artefacts in the fossil record, a possibly confounding effect on existing macroevolutionary models. (e.g. the fossilized birth-death process).

THE POSTCRANIAL SKELETON OF THE BASAL RUMINANT NANOTRAGULUS (ARTIODACTYLA: HYPERTRAGULIDAE) FROM THE INIYOO LOCAL FAUNA, EARLY OLIGOCENE (ARIKAREEAN) OF SOUTHERN MEXICO

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The genus *Nanotragulus* (Artiodactyla: Hypertragulidae) is an extinct basal ruminant with a chronological range from the early Oligocene to the early Miocene of North America (Whitneyan-Arikareean), and is a typical mammal for the Arikareean. The skeleton of this genus was previously described by Loomis (1933) from Porcupine Creek in South Dakota, with other known occurrences of fragmentary skeleton remains in the states of Oregon, Nebraska, Texas and Florida. Here we present the postcranial skeleton of *Nanotragulus*, collected from early Oligocene fluvio-lacustrine sediments that crop out in the surroundings of Santiago Yolomécatl, in Northwestern Oaxaca, Mexico. We describe the postcranial bones that consist of vertebrae, radius-ulnae, carpal bones (Scaphoid), metacarpals, metatarsals, humeri, tibiae, calcanea, astragali, phalanges and partial broken ribs. Several bones show differences in size, suggesting the presence of two morphotypes in our sample. *Nanotragulus* represents the only genus of the Hypertragulidae family in Yolomécatl, where it is associated with a diverse Paleogene mammal fauna. The study of the *Nanotragulus* postcranial skeleton provides a broader insight of the metric and morphological variations between the Oaxaca and North American specimens. Previous U-Pb zircon dating of a sandstone bed that overlies the fossiliferous beds dated the fauna as a maximum of 30.6 Ma, and by mammalian biochronology the faunal assemblage is 28-29 Ma in age, making it the southernmost land mammalian assemblage of early Arikareean (early Oligocene) age in North America. The geographic distribution of the genus is expanded by 1,400 km south and constitutes the southernmost North American record of the genus *Nanotragulus*.

A CIRCUM-TROPICAL DISASTER BED IN THE EARLY AFTERMATH OF THE END-ORDOVICIAN MASS EXTINCTION

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The end-Ordovician glaciation and mass extinction was associated with unusual inorganic carbonate production and preservation through wide expanses of contemporaneous shallow seas in Earths tropical zone. This resulted in widespread ooid formation and locally in botryoidal cements, a post-extinction carbonate production change only well studied in the earliest Triassic of the Tethys Realm. High-resolution correlation by means of stable carbon isotope stratigraphy reveals a late early Hirnantian (stage slice Hi1 and the early *Metabolograptuspersculptus* chron)