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CONVERGENT EVOLUTION IN TOOTH MORPHOLOGY OF FILTER-FEEDING LAMNIFORM SHARKS

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ABSTRACT

The basking shark (*Cetorhinus maximus*) and megamouth shark (*Megachasma pelagios*) are two species of filter-feeding sharks, both belonging to the order Lamniformes. There are two conflicting hypotheses regarding the origins of filter feeding in lamniform sharks; that there is a single origin of filter feeding within Lamniformes, or conversely, the filter-feeding adaptations have been developed independently due to different ancestral conditions. Evidence obtained from several morphological and molecular studies strongly supports the latter hypothesis. Because evidence suggests that *Megachasma* and *Cetorhinus* have developed their filter-feeding adaptations independently, we hypothesized that convergent evolution in tooth morphology is taking place within these two lineages. Geometric morphometric analyses were performed on fossil and recent teeth of *Megachasma* and *Cetorhinus* to determine if there is commonality among tooth shape. Increasingly similar shapes in recent teeth compared with fossil teeth would provide one piece of evidence to support this hypothesis. Relative warp axes were interpreted using percent variation explained and compared by species. Multivariate analyses of variance (MANOVA) were used to test for significant morphological differences in fossil and recent teeth of each species and a series of one-way analyses of variance (ANOVA) with corresponding Tukey intervals (95% CI) was used to test for morphological differences in overall mean tooth shapes between fossil and recent *Megachasma* and *Cetorhinus* teeth for each significant relative warp axis. The results of the MANOVAs showed significant differences in fossil and recent *Megachasma* and *Cetorhinus* teeth and support independently derived filter-feeding adaptations and the results of the ANOVAs and corresponding Tukey intervals support convergent evolution in tooth morphology within these two species of filter-feeding lamniform sharks.

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MINERALOGICAL AND GEOCHEMICAL CONSTRAINTS ON THE ORIGIN OF KYANITE QUARTZITES IN THE KINGS MOUNTAIN TERRANE, NORTH CAROLINA AND SOUTH CAROLINA

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ABSTRACT

Deposits rich in kyanite, sillimanite, or andalusite are abundant in the southeastern U.S. Recent interpretations favor alteration of the volcanic protoliths of these deposits via leaching by highly acidic hydrothermal fluids. Although this interpretation seems widely accepted, geochemical data that could be used to evaluate it in more detail have not been reported for most occurrences. The purpose of this study is to evaluate the origin of kyanite quartzites in the Kings Mountain Terrane, specifically using the high-sulfidation alteration model of Owens and Pasek (2007) for occurrences in Virginia as a guide. Evidence for this model includes ubiquitous rutile, bulk compositions dominated by SiO_2 and Al_2O_3 (with negligible MgO, CaO, and alkalis), strong depletion of Ga relative to Al, and unusual ladle-shaped chondrite-normalized REE patterns.

We investigated kyanite quartzites from Crowders Mountain, The Pinnacle, and Henry Knob, which all occur within the Cambrian Battleground Formation. Rocks from all areas are dominated by quartz and kyanite, with smaller and variable amounts of muscovite + rutile ± pyrite. Bulk compositions of all samples are rich in SiO_2 and Al_2O_3, as expected. Amounts of Fe_2O_3(T) are typically low but variable, reflecting either the amount of pyrite or intensity of Fe-staining (which is locally pervasive). The amount of TiO2 is typically ~0.6 wt%. All other oxides are present only in trace amounts. Gallium is depleted relative to Al, but not to the same extent as in the Virginia occurrences. All samples also show the unique, ladle-shaped REE patterns displayed by the Virginia rocks. Thus, these kyanite quartzites display all of the features of the Virginia rocks, and we conclude that the same high-sulfidation alteration model can be applied here. In addition, various tectonic setting discriminant diagrams indicate an arc setting for the protoliths, consistent with the known settings of high-sulfidation hydrothermal alteration systems.

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Stratigraphy, palynology, and paleoecology of ancient freshwater wetlands, St. Catherines Island, Georgia, USA

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ABSTRACT

St. Catherines Island is one of several barrier islands along the coast of Georgia, in the southeastern United States. Many of the islands are believed to have similar geological and biological histories. We know St. Catherines to be unique in having a very well documented pre-historic and historic human presence. Native Americans lived on the island for thousands of years due to two factors: there was a readily available artesian spring-fed freshwater supply, and it lay in proximity to a shallow water marine source of abundant food (oysters, clams, fish). While the abundance of surface freshwater on the island was documented by 18th Century European explorers, there has been little in the written geological record to illustrate and confirm that history. We provide evidence that ancient freshwater wetlands in an area known as the Central Depression appeared long ago and left a nearly continuous history of freshwater conditions in areas now dominated by a dry pine-oak-palmetto floral assemblage.

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WOOD SILICIFICATION: A MOGANITE MYSTERY

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ABSTRACT

Moganite and quartz are the only minerals observed in silicified wood logs from Upland Complex (UC, Pliocene) gravel in the Mississippi Embayment. Logs now in the UC silicified in the Eocene and, 30 million years later, were incorporated in the UC during incision of the Pliocene Mississippi River into subjacent fluvial/deltaic deposits of the Claiborne and related units. Moganite is a relatively uncommon mineral. Is the mineralogy of these samples due to an unusual mode of silicification or is it a consequence of improved technology? To answer these and related questions, XRD and petrography were used to analyze the mineralogy, mineral texture, and wood texture of 41 logs of silicified wood from UC gravel and 38 logs from a variety of other settings. UC logs are well-rounded dense chert. Moganite content ranges from absent to 15 percent with a gap in range. The quartz Crystallinity Index ranges from 10 to one with a gap in range. Thin sections revealed quartz in all samples, chert in many, and length-slow chalcedony in some. The mineral composition of UC samples and samples not from the UC are similar. No sample of silicified wood has cristobalite or tridymite, minerals common in geologically young chert. Moganite is absent in pre-Cenozoic samples. Moganite and length-slow chalcedony are common in Cenozoic permineralized wood but not in petrified wood, a distinction not possible until late 20th century advances in XRD technology.