SKULAN

Although these sensitive techniques have been available for quite some time, exploration of the wide range of naturally occurring trace elements in the mineral matter of modern bones and teeth have not been adequately investigated. We know that living skeletons act as a filter, integrating what is ingested, but the permissible upper limit before an element becomes hazardous, copper and arsenic, for example, are not known. Studies on fluorine have shown one mechanism tied to the mineral crystallography. Paleoskeletal chemistries may represent extreme uptake for some elements but the results from such studies may help us to define the boundaries and mechanisms for other elements. Chemical data on fossil mineralized materials could enable us to predict potential pathological environmental exposures.

A TALE FROM THE CRYPT: STRUVITE MINERALIZATION IN A ROTTING RHINOCEROS

SKULAN, Joe, University of Wisconsin, Lodi, WI; KUCHTA, Matt, University of Wisconsin, Madison, WI.

In 1983 the headless carcass of a white rhinoceros (*Ceratotherium simum*) was buried on the University of Wisconsin, Madison campus. The carcass was buried in sandy, oxygenated and well drained but perpetually moist soil at a depth of 2m. The temperature presumably was fairly constant at Madison's mean annual temperature of 7.3C. Burial conditions were selected to maximize the rate of decay, while minimizing damage from freeze-thaw and plant roots.

In the spring of 2002 the carcass was exhumed. The hind limbs and the distal forelimbs were largely flesh-free, although fragments of toe pads were recovered from the front feet. The bulk of the carcass was surrounded by a thick layer of adipocere. The chest and abdominal cavities were hollow and contained remains of internal organs and gut contents. The muscles of the forelimbs and shoulder were moist, pliable, and bright red. Very little skin was preserved.

Given the presence of oxygen around the carcass (attested by the presence of insects), and the fact that the carcass had been exhumed and reburied in the early 1990's, the observed soft tissue preservation was remarkable. Microbiological and geochemical examination of tissue samples may shed light on the early diagenesis and possible mechanisms for long-term preservation of soft tissues.

Of particular interest are crystals of struvite (ammonium calcium phosphate hydrate) growing in voids between bones. Struvite occurs only in association with the decomposition of nitrogen-rich organic material, such as guano. As such, struvite may be a marker for preserved soft tissue. Moreover, the calcium and the phosphate components of struvite have three potential sources: bone, soft tissue and groundwater. Each source has a distinct calcium and oxygen isotope composition. If groundwater is not the sole source of calcium and phosphate in struvite, struvite should indicate the presence of soft tissue by its Ca and O isotope compositions. Over time struvite may alter into other minerals, such as apatite, by the loss of NH_4, but this alteration should not erase the original soft tissue isotopic signal.

EARLY PERMIAN TETRAPOD ICHNOFAUNA FROM THE MAROON FORMATION, COLORADO: AGE, PALEOECOLOGICAL, AND BIOSTRATIGRAPHIC SIGNIFICANCE

SMALL, Bryan, SANDERS, Frank, Denver Museum of Nature & Science, Denver, CO.

The Maroon Formation of central Colorado is a massive nonmarine red bed unit (4,600 m thick) deposited in a subsiding cratonic basin. Conglomerates, coarse-grained sandstones and a few thin limestones dominate the lower half of the Maroon Formation. Siltstones and fine-grained sandstone units dominate the upper half of the Maroon Formation. The Maroon Formation is tentatively dated as Pennsylvanian/Permian, with no good age constraint at the top of the formation. There are non-vertebrate traces and a few plants of little chronostratigraphic value present. Conspicuously absent from the Maroon are vertebrate body fossils and vertebrate tracks, except for one reported but undescribed lacertoid trackway.

Hundreds of tracks were recently discovered from a high altitude (3,600 m) site in the Maroon Bells Wilderness Area, White River National Forest, administered by the United States Forest Service. The tracks (including trackways) come from one horizon in the upper half of the formation. The tracks occur in associated large blocks that are not in situ. The verticality of the strata prevents precise stratigraphic placement. The three ichnotaxa in the Maroon Bells assemblage are: *Ichniotherium cottae* (Diadectidae) (the most common track); *Varanopus* sp. (Captorhinomorpha); and *Dimetropus* sp. (Eupelycosauria). The conifer *Walchia* dominates the plant remains associated with the prints.

The Maroon Bells tetrapod ichnotaxa assemblage is important in that: 1) it provides the best record of *Ichniotherium* outside of Europe; 2) the assemblage strongly resembles the Tambach Formation assemblage of Germany, with the Maroon Bells taxa representing three of the four Tambach ichnotaxa, strengthening the faunal ties recently established between the Tambach Formation and some Early Permian redbeds in North America; 3) the Tambach Formation is considered Wolfcampian in age, suggesting the same age for the previously undated upper Maroon Formation; and 4) the Tambach Formation is interpreted as a rare Early Permian herbivore-dominated upland paleoecosystem, suggesting the same for the Maroon Bells track site.

NEW SPECIES OF *ISCHNACANTHUS* (ACANTHODII: ISCHNACANTHIFORMES) FROM CANADA: SIMILARITIES TO EXTANT SPECIES FLOCKS

SMITH, Chelsea, WILSON, Mark, University of Alberta, Edmonton, Alberta, Canada

The ischnacanthiform genus *Ischnacanthus* is known from several species in two main geographic areas. The two largest collections of *Ischnacanthus*, *I. gracilis* from the Early Devonian Old Red Sandstone (ORS) of Scotland, and a collection of specimens previously described as *I. gracilis* from the Early Devonian Man On The Hill (MOTH) fish beds, Mackenzie Mountains, NWT, Canada, are preserved as both body fossils and isolated jaw elements.

Several new species have been identified from the MOTH collection based on dental morphology. In addition, all MOTH ischnacanthiforms possess a small cusp at the base of the medial surface of each main tooth, a feature not described for *I. gracilis*, suggesting a monophyletic origin for the MOTH species. The jaws of the new species differ markedly from ORS *I. gracilis* in dental morphology, although body fossils are remarkably similar to each other and to ORS specimens. Body fossils differ from *I. gracilis* in only a few features: MOTH specimens are deeper-bodied and possess enlarged scales at the bases of the fin spines.

Morphological similarity of the bodies of the fishes in the two most abundant ischnacanthiform assemblages raises the question of the degree of conservation of the body morphology of ischnacanthiform acanthodians during the Early Devonian. Perhaps body morphology changed little, while new patterns of dentition arose through selection for exploitation of different food sources. A modern analog can be found in Lake Victoria, Africa, which contains a diverse species flock of cichlid fishes. Body morphology of Lake Victoria cichlids is conservative whereas dental characteristics differ significantly, each species' dentition suited to different dietary specializations. The similarity in posteranial anatomy of species from MOTH and the ORS, and the fact that the new species from MOTH are only distinguishable using dental features, may have resulted from similar selective pressures to those experienced by Lake Victoria cichlids where significant evolutionary change occurred only in dental characteristics.

CRANIAL VARIATION WITHIN *ALLOSAURUS FRAGILIS*

SMITH, David, Brigham Young Univ., Provo, UT.

A considerable amount of non-size-related variation exists within some of the bones making up the crania of *Allosaurus fragilis*. Specimens from Dry Mesa, Cleveland-Lloyd, Dinosaur National Monument, Como Bluff, and an isolated site in eastern Utah were compared to document this variation. Some of the differences include changes in the orientation of paroccipital processes and the arrangement of the bones making up the basisphenoidal recess. Allometric variation in the pneumatic recesses in the wall of the basisphenoid was noted previously. Differences also exist in the supraoccipital and parietal bones making up the nuchal and parietal crests. The prootic, laterosphenoid, and opisthotic are fairly conservative. There also appears to be little non-size related endocranial variation, but these results are based on limited information. The available specimens include a bisected specimen and prepared endocranium, both from Cleveland-Lloyd, and ct-scan results of a larger specimen from Dry Mesa. As in other elements, braincases from Cleveland-Lloyd tend to be smaller than those from other sites.

The observed variation is not a function of the geographic location, stratigraphic position, or size of the animal. These results have functional and systematic implications. A posterior deflection of the paroccipital processes would limit lateral skull movement, while apparently permitting dorso-ventral movement at the occipital condyle. At this point, all of the material is regarded as being derived from a single variable species, *Allosaurus fragilis*.

FOSSIL VERTEBRATES FROM THE KAIPAROWITS FM, GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT: AN IMPORTANT WINDOW INTO THE LATE CRETACEOUS OF UTAH

SMITH, Joshua, SAMPSON, Scott, ROBERTS, Eric, GATES, Terry, GETTY, Mike, ZANNO, Lindsay, University of Utah/Utah Museum of Natural History, Salt Lake City, UT.

Recent paleontological work conducted by the Utah Museum of Natural History has yielded abundant new evidence of fossil vertebrates in the Upper Cretaceous Kaiparowits Formation in the Grand Staircase-Escalante National Monument. Dinosaur and other vertebrate remains have been previously recovered from the Kaiparowits, but few have been diagnosed to species level because of lack of identifiable remains. This project, financially supported by GSENM, seeks to identify new specimens from the Late Cretaceous of southern Utah and understand their temporal, ecologic, and phylogenetic implications.

As a result of three years of intense prospecting and excavation, a diverse fossil vertebrate assemblage has been recovered including fish, amphibians, and lizards. The largest and most conspicuous components of the fauna are the numerous dinosaurian taxa. One of the major discoveries is that of a partial skull from a new chasmosaurine ceratopsid as well as representative elements from the posteranium. Evidence of other ornithischian taxa includes ankylosaurs, lambeosaurine and hadrosaurine hadrosaurs, a pachycephalosaur, and a basal ornithopod. Theropod remains include the partial skeleton of a large tyrannosaur, a small caenagnathid, and less diagnostic material from other maniraptorans and ornithomimids.

Previous researchers have suggested the Late Cretaceous Western Interior contains two latitudinally distributed biozones (ie. a distinct northern fauna and a distinct southern fauna). Utah has been hypothesized to occur at the boundary between the biozones and may represent a zone of faunal interchange. Ultimately, descriptions of these new taxa from the Kaiparowits Formation sediments of GSENM will enable comparisons with coeval faunas both north and south, allowing paleontologists to test an array of ecological and evolutionary hypotheses.

ON THE OCCURRENCE OF *MAJUNGATHOLUS ATOPUS* IN INDIA: IMPLICATIONS FOR ABELISAUROID PALEOBIOGEOGRAPHY

SMITH, Joshua, Washington University, St. Louis, MO; KRAUSE, David W., Stony Brook University, Stony Brook, NY.

Given their pattern of distribution and the poor Gondwanan Cretaceous tetrapod record as a whole, abelisauroid occurrences are paleobiogeographically important. Whereas abelisauroids are well known from South America and Madagascar, they have long been rep-

J Vert Paleont. 23 (3), 2003