

tions and systematic reassessment of the fauna demonstrate a strong similarity to the Australasian and South China succession and necessitate a substantial revision of the Ordovician zonation. Additionally, the Trail Creek succession is more incomplete than previously thought. The first 15 meters of back shale above the base of the section contain an interrupted sequence of Lower and Middle Ordovician faunas. Collections at 1.0 and 1.8m contain *Xiphograptus lofuensis*, *Tetragraptus reclinator*, *T. serra*, *Didymograptella bifidus*, and *Pseudotrigraptus ensiformis*, a fauna referable to Chetwintonian-2. Collections at 2.15m, in contrast, contain *Arenigraptus gracilis* and *Isograptus maximodivergens*, taxa indicative of Castlemainian-4. Yapeenian and Darrwillian faunas are mostly missing from the Phi Kappa Fm. at Trail Creek (though present in other sections). The subsequent 135 meters of strata contain a more complete succession of Upper Ordovician zones. We have substantially lowered the bases of the *N. gracilis* and *C. bicornis* zones (by nearly 60 meters in the latter case, through the entire sandy interval in the middle part of the section). The upper part of the *C. bicornis* Zone and lowermost part of the succeeding "Passage Beds" contain a sparse early Eastonian fauna (Ea1-2) that includes *Climacograptus spiniferus*. The first appearance of *C. tubuliferus* occurs near the base of the "Passage Beds," and is correlative with the base of the Ea3. The *Dicellograptus gravis* Zone (Ea4) appears at the level formerly identified at Trail Creek as the base of the *C. tubuliferus* Zone. Bolindian-1 faunas occur within the upper part of that interval and Bo2 faunas occupy most of the interval identified as the *Pleurograptus linearis* Zone. Finally, the most diverse assemblages, those of the Bo3, are present in the former *Dicellograptus ornatus* Zone interval. *D. ornatus* itself, however, appears within the Bo1 along with *Climacograptus uncinatus*.

187-38 BTH 71 Ausich, W.I.

NEW LATEST ORDOVICIAN (RAWTHEYAN AND HIRNANTIAN) CRINOID FAUNAS FROM ANTICOSTI ISLAND, QUEBEC, CANADA

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The Ordovician-Silurian strata on Anticosti Island are, apparently, a complete succession from the Rawtheyan (Richmondian) through the Telychian. These strata were deposited in a shallow-water mixed carbonate-siliciclastic setting that supported an abundant and diverse fauna. For the first time, crinoids have been systematically sampled through this section. Relatively few Hirnantian and Llandoveryan crinoid faunas were known previously, so these faunas provide an unparalleled opportunity to examine the fabric of extinctions and evolution across the Ordovician-Silurian boundary, which witnessed a macroevolutionary change in the composition of crinoid faunas. Crinoids are known from ten members of two Ordovician formations on Anticosti Island: the Rawtheyan Vauréal Formation and the Hirnantian Ellis Bay Formation. A rarefaction analysis considering the history of collections of each formation indicates that these faunas are reasonably well sampled. The Rawtheyan crinoid fauna has 12 species, organized in communities with various diversities, one to eight species, with the highest diversity in the LaVache Member. The Vauréal fauna is typical for the Rawtheyan with *Gaurocrinus*, *Xenocrinus*, *Dendrocrinus*, *Cupulocrinus*, *Plicodendrocrinus*, and *Carabocrinus*. It also contains *Cleidochirus*, *Chirocrinus*, and *Eomyelodactylus*. However, this fauna is lower in total diversity than other Rawtheyan faunas such as the Cincinnati, Ohio area (17), the Maquoketa Shale of Iowa and Illinois (20), and the Threave Glen Starfish bed of Scotland (19). Nine species occur in the Hirnantian Ellis Bay Formation, with community diversity of one to four. The most diverse communities occur in the two upper members, the Lousy Cove and Laframboise, with four species each. Crinoids in this fauna include a new rhodocrinitid camerate, a new monorathrid camerate, *Xenocrinus*, *Dendrocrinus*, *Euspirocrinus*, *Calceocrinus*, and *Charactocrinus*. The best documented Hirnantian crinoid fauna is the Girardeau Limestone in Missouri, which is much more diverse (15 species).

187-39 BTH 72 Kammer, Thomas W.

BIOSTRATIGRAPHIC CONSTRAINTS ON THE TIMING OF VALLEY INCISEMENT AND DEPOSITION OF THE LOWER MISSISSIPPIAN BLACK HAND SANDSTONE OF OHIO

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The Black Hand Sandstone Mbr. of the Cuyahoga Fm. is up to 60 m thick and consists almost entirely of nonmarine, cross-bedded, coarse-grained, conglomeratic sandstone. We interpret the Black Hand as braided river sediments filling incised-valleys within finer-grained marine sediments of the Cuyahoga. Available biostratigraphic data points to late Kinderhookian incision followed by an early Osagean transgression.

By combining previous biostratigraphic studies (e.g., Fagadau, 1952; Hyde, 1953; Rodriguez, 1961; Manger, 1971, 1979; Thompson et al., 1971; Gordon and Mason, 1985; Coleman and Clayton, 1987; Clayton et al., 1998; Sandberg, Mason, and Work, 2002) on various taxa (brachiopods, ammonoids, conodonts, miospores) it can be demonstrated that the overlying Logan Fm., and the equivalent Borden Fm. of eastern KY, is early Osagean (Tn3) age. The age relationships of the various members of the Cuyahoga are more complex. In general, the Cuyahoga is time-transgressive from north to south. In northern Ohio nearly all reported species from the Orangeville, Sharpsville, and Meadville members are restricted to the Kinderhookian (Tn2) (Szmuc, 1957). In southern Ohio, near the Ohio River, ammonoids and conodonts in the basal Henley Member indicate the Cuyahoga is predominantly early Osagean age (Sandberg, Mason, and Work, 2002). In central Ohio the Kinderhookian-Osagean (K-O) boundary is thought to occur within the upper Cuyahoga, but precise correlation is equivocal because of missing time within the unconformity at the K-O boundary in the Mississippi Valley.

Based on: A) the above age relationships, B) the unconformity at the K-O boundary of the Mississippi Valley, C) reports of Tournaisian (Tn2) tillites on Gondwana (Crowell, 1999), and D) the positive C13 anomaly in the late Kinderhookian (Mii et al., 1999; Saltzman, 2002) the following can be inferred. 1) a glacial eustatic drop in sea level in the late Kinderhookian produced incised valleys in the Cuyahoga Fm.; 2) the valleys filled with braided stream deposits during an early Osagean sea level rise; and 3) the continued rise in sea level flooded the top of Black Hand, where marine fossils occur, and deposited the overlying Logan Fm.

SESSION NO. 188, 8:00 AM

Wednesday, October 30, 2002

Paleontology/Paleobotany VI: Terrestrial Paleoenvironments and Biostratigraphy Colorado Convention Center, A105/107

188-1 8:00 AM Patrick, Doreena

THE USE OF TERNARY DIAGRAMS IN RARE EARTH ELEMENT (REE) ANALYSIS OF FOSSILS AND INTERPRETATION OF THE ORIGINAL PALEOENVIRONMENT

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Rare Earth Elements (REE) analysis on fossil bones has recently been used to interpret reworking, time averaging, and fossil provenience. Data have been displayed in NASC normalized spider diagrams. The REE patterns define a "signature" for each of the studied specimens. These signatures can be interpreted as "fingerprints" for stratigraphic units. REE signatures reflect the original waters of deposition and therefore can be used for paleoenvironmental interpretation. A better method for visualizing variations in REE patterns is by use of a ternary diagram. Representative Light (LREE), Middle (MREE) and Heavy (HREE) rare earths occupy the vertices of the triangle. We use Pr or Nd, Gd, and Yb as the representative end members. The ternary diagram allows the basic shape of the REE pattern to be represented by a single point. Mixing lines between environmental end members may be shown in such diagrams. These ternary diagrams can be compared with natural waters to infer the original water conditions. Examples of mixing as a function of stratigraphic level in the Cretaceous Pierre Shale of South Dakota and the Pleistocene of Fossil Lake, Oregon, will be presented.

188-2 8:15 AM Santiago-Blay, Jorge A.

CHEMICAL ANALYSES OF FOSSIL AND MODERN PLANT RESINS USING C-13 SSNMR SANTIAGO-BLAY, Jorge A.¹, LAMBERT, Joseph B.² and WU, Yuyang², (1) Department of Paleobiology, MRC-121, National Museum of Nat History, 10th and Constitution Avenue, Smithsonian Institution, P. O. Box 37012, Washington, DC 20013-7012, blayj@nmnh.si.edu, jsantiago@harper.uchicago.edu, (2) Department of Chemistry, Northwestern Univ, 2145 Sheridan Road, Evanston, IL 60208-3113

Fossilized plant resin, or amber, is notable in having exquisitely preserved organisms or parts of them. Additionally, some features of the biology of these organisms are traceable to the Lower Cretaceous (ca. 130 Ma). Resins, complex mixtures of carbon-rich molecules insoluble in water, have been produced by numerous ancestral vascular plants, including the Medullosales, since as early as the Middle Carboniferous (ca. 305 Ma). Of all plant exudates, including resins, latexes, and gums, distributed in over 485 genera and 144 plant families, it appears that only resins occur in geologic deposits. Nevertheless, the botanical source of many ancient resins remains obscure. As the chemical nature of resins may vary with plant species, the characterization of modern resins by different physicochemical techniques are used to establish the likely botanical origin of ancient resins. However, ancient resins are seldom associated with taxonomically diagnostic plant organs or tissues. C-13 SSNMR is a state-of-the-art research tool that generates spectra (or signatures) of solids. This technique is the only method that can distinguish the botanical sources of a wide variety of ancient and modern resins. Our analyses use a tiny amount of the solid resin (< 0.5 gram) and are non-destructive. Peaks in different regions of the spectra represent different kinds of chemical bonds, distinguished by their resonances, present in the sample. Data from these resins will be presented from four research areas of evolutionary paleobiology. First, the refinement of our knowledge of fossil and modern plant resins by generating a library of C-13 SSNMR chemical signatures for them. Second, from a chemical library of exudate samples, the identification and reconstruction of resiniferous forests can take into account varied plant species that may have been diachronous sources in the same general locality. Third, given the large number of modern resin samples at hand from closely-related plants, there is a basis for commenting on their classification. Fourth, more ancient resin samples may yield data useful to understand the evolution of plant resin types. These chemical approaches provide an alternative and complementary methodology for reconstructing resin-producing forests, particularly for lineages with extant representatives.

188-3 8:30 AM Green, Walton A.

PHENETIC CLASSIFICATION OF LEAF FLORAS: A COMPARATIVE EXPERIMENT

GREEN, Walton A. and HICKEY, Leo J., Department of Geology and Geophysics, Yale Univ, P. O. Box 208109, Yale Station, New Haven, CT 06520, walton.green@yale.edu Classification of plant ecosystems is a difficult task that has occupied many of the great plant ecologists of the early twentieth century, and the proliferation of personal computers since the 1980s has not yet had nearly the impact upon ecological classification that it has upon systematics. This paper describes a comparative experiment that applies a number of phenetic (clustering) algorithms to modern and fossil leaf floras numerically described by two sets of leaf architectural variables, one from the Climate Leaf Analysis Multivariate Program (Wolfe, 1993), and one from the cataloging system of the Compendium Index of North American Fossil Plants at Yale University (Ash et al., 1999). The classifications produced by these different sets of variables are similar and reflect what is known about the ecologies of the floras analyzed. This implies that the ecological signal from leaf architecture is insensitive to the method of quantitative leaf description and strong enough to be heard despite taphonomic or methodological biases.

References: Ash, A., B. Ellis, L. J. Hickey, K. Johnson, P. Wilf, and S. Wing (1999) *Manual of Leaf Architecture: Morphological Description of Dicotyledonous and Net-Veined Monocotyledonous Angiosperms*. Privately published and distributed. Washington, D.C.: Smithsonian Institution. Wolfe, J. A. (1993) A method of obtaining climatic parameters from leaf assemblages. *U.S. Geol. Surv. Bull.* 2040:1-73.