Paleoenvironments, Paleoecology, and Exceptional Preservation in Burgess Shale-type Deposits

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Cambrian Burgess Shale-type (BST) deposits occur worldwide and offer a remarkable window on the initial Phanerozoic radiation of the Metazoa. However, BST deposits also represent significant deviations from the constraints that govern the typical operation of the fossil record. These deviations remain to be adequately accounted for, hindering interpretations of the paleoecology of their exceptional biotas and the environments in which they lived. This talk will provide an overview of ongoing research towards developing a model for understanding paleoenvironments, paleoecology, and exceptional preservation in BST deposits, using data from 12 deposits of North America, Scandinavia and South China. Recently, elemental mapping of a survey of BST fossils demonstrated that the mode of fossilization is unique and common to all deposits. Thus, preservation of BST assemblages represents a single phenomenon that may share a common cause in all deposits in which it occurs. Sedimentologic and stratigraphic data indicate that BST deposits occur in a particular physical depositional window that acted as a first-order control, determining where exceptional fossilization occurred. Ichnologic and geochemical data indicate that, within the favorable physical depositional setting, benthic redox conditions exerted the next control. BST deposits occur at the transition from oxic to anoxic benthic environments and demonstrate dynamic redox conditions during deposition; exceptional fossils are confined to anoxic intervals. The chemistry of the early burial environment is interpreted to have exerted the final control. Ongoing work using the $\delta^{34}S$ system from a core through the Chengjiang deposit extracted in July 2008 will provide a test of the hypothesis that sediment sealing by early carbonate cements promoted an early cessation of decay. Constraints at each tier, from the regional scale to the micron scale, were strongly favored by the prevalence of large epicratonic seaways in the Cambrian and by greenhouse conditions.