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Short-term Fallout Radionuclide Ratios and Mass Balance Identify New Suspended Sediments of Channel Origin and Importance of Catchment Flowpath

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Fallout radionuclides and their ratios, such as beryllium-7 (7Be) and lead-210 (210Pb), are used to determine suspended sediment source and age in catchments. The ratio of beryllium-7 to lead-210 (7Be/210Pb) on suspended sediment has been used to estimate the fraction of “new” sediment in suspension. In the application of this model, “new” suspended sediment is often assumed to originate from recent landscape surface erosion that is delivered to the stream network. Fallout radionuclide deposition can vary across watersheds and on an event basis in a single watershed due to factors such as storm type, atmospheric height, and storm origin. In the White Clay Creek watershed within the mid-Atlantic USA, single-event deposition of 7Be varies from 15 – 177 Bq m-2 and 210Pb varies from 0 – 10 Bq m-2. 7Be/210Pb ratios vary from 7.9 to 17 within event precipitation and from 0.8 to 12.8 on suspended sediment. “New” sediment varies from 6 – 100% over the course of these events. 7Be mass balance during events shows that the majority of 7Be is retained within the catchment and not exported on suspended sediment. During summer thunderstorms, less than 1% of 7Be deposited on the watershed exits the stream channel. By comparing this flux with the direct channel interception of 7Be deposition in precipitation and throughfall we can determine the minimum amount of 7Be leaving the watershed that could occur in the absence of surface erosion. For example in summer thunderstorms, the entirety of the 7Be exiting the watershed on suspended sediment is less than the total activity deposited on the channel in direct precipitation. Channel-intercepted fallout radionuclides can exit the catchment by multiple mechanisms including the tagging of subaerial fluvial deposits with event precipitation; hence “new” suspended sediment originates from within the channel rather than from surface erosion. During extreme events, such as Hurricane Irene, less of the suspended sediment has been newly tagged by precipitation (4 – 28%) and a larger proportion (3-4%) of the 7Be deposited on the watershed exits during the event. Ongoing work in the Difficult Run watershed in northern Virginia will test the regional applicability of these findings. Water quality efforts to determine the source of sediment using fallout radionuclides must consider the stream channel as well as landscape sources of “new” sediments, particularly during summer thunderstorms in watersheds with subaerial but not fully submerged fluvial deposits.