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Mean Transit Times in Seven Upland Catchments, Otway Basin, Southeast Australia

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The timescales over which precipitation is transmitted into upland streams (the mean transit times, MTTs) are poorly understood, as are the physical processes and controls that govern the variation in mean transit times. In this study, we use tritium (3H), major ion geochemistry and discharge data to investigate the MTTs in upland streams of the Otway Basin of southeast Australia. Samples were collected under varying discharge conditions from seven catchments of varying size whose land use varies from relatively pristine eucalyptus forest to a mixture of pasture, grazing, and production forestry. This allows the controls on MTTs to be assessed.

Tritium activities within the streams varied from 0.20 to 2.35 TU, which are below that of local rainfall (∼2.7 TU). The highest tritium activities were generally reported in samples collected during periods of high winter discharge, while the lowest tritium activities were reported in samples collected during low, summer discharge. However, at several of the streams, there appears to be a discharge threshold above which tritium activities do not increase appreciably with increased discharge. In general, streams with larger catchment areas and relatively simple geology have less variable but higher tritium activities. In contrast, the lowest and most variable tritium activities were reported in streams having small catchment areas and a greater complexity in geology. MTTs calculated using an exponential-piston flow model ranged between 8 and 180 years; MTTs calculated using other flow models were generally similar, except where the tritium activities were less than around 1 TU. Major ion concentrations generally increased with a corresponding increase in MTT. However, in those streams having more variable MTTs, the opposite often held true, which most likely reflects the variable contribution to flow by water from different geologic units under differing flow conditions. By contrast, land use does not appear to impart a significant control on residence times. The MTTs may also be used to estimate baseline nitrate and sulphate concentrations, prior to water quality impacts associated with European settlement and land clearing.