

Influence of soil processes on groundwater composition, southeastern Australia

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The soil, soil water and groundwater chemistry in the upper Wimmera region of southeastern Australia was investigated to determine the cause of the observed differences in relative abundances of cation species between rainfall and groundwater.

The relative concentrations of the major cations, particularly the divalent species Mg^{2+} and Ca^{2+} , are rapidly depleted by adsorption to clay minerals in the shallow soil zone. The monovalent cations Na^+ and K^+ initially exhibit minor enrichment through a combination of cation exchange, and possibly the decomposition of organic material, prior to depletion. The concentrations of K^+ and Ca^{2+} , both on cation exchange sites and in groundwater, are partly controlled by the uptake of nutrients by vegetation, a process largely neglected in the study of Australian groundwater chemistry. The cation/Cl⁻ ratios are generally reduced from the initial rainfall ratios to ratios typical of mean groundwater within the upper two metres of the soil profile.

The evolution of groundwater chemistry in the catchment can be explained by mixing between two distinct sources of recharge: (a) low salinity water that infiltrates rapidly through thin soils and rocky outcrop, retaining a rainfall-like chemical signature, and (b) high salinity water that infiltrates slowly through the clay-rich soil and regolith profiles of the floodplain, and which has had its chemistry modified by the processes described above to resemble diluted seawater. This mixing produces the characteristic exponential decline in cation/Cl⁻ ratios with increasing salinity, a phenomenon observed in groundwater systems throughout the world.

This study shows that much of the chemical evolution traditionally attributed to groundwater processes within the aquifer is complete by the time recharge occurs.