Hydrology and Earth System Sciences
An Interactive Open Access Journal of the European Geosciences Union

Hydrol. Earth Syst. Sci., 12, 1-19, 2008
www.hydrol-earth-syst-sci.net/12/1/2008/

A conceptual model of flow to the Waikoropupu Springs, NW Nelson, New Zealand, based on hydrometric and tracer (^{18}O, Cl, ^{3}H and CFC) evidence

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Abstract. The Waikoropupu Springs, a large karst resurgence 4 km from the coast, are supplied by the Arthur Marble Aquifer (AMA) underlying the Takaka Valley, South Island, New Zealand. New evidence on the recharge sources in the catchment, combined with previous results, is used to establish a new recharge model for the AMA. Combined with the oxygen-18 mass balance, this yields a quantitative description of the inputs and outputs to the aquifer. It shows that the Main Spring is sourced mainly from the karst uplands (74%), with smaller contributions from the Upper Takaka River (18%) and valley rainfall (8%), while Fish Creek Spring contains mostly Upper Takaka River water (50%). In addition, much of the Upper Takaka River contribution to the aquifer (58%) bypasses the springs and is discharged offshore via submarine springs. The chemical concentrations of the Main Spring show input of 0.5% of sea water on average, which varies with flow and derives from the deep aquifer. Tritium measurements spanning 40 yr, and CFC-11 measurements, give a mean residence time of 8 yr for the Main Spring water using the preferred two-component model. Our conceptual flow model, based on the flow, chloride, oxygen-18 and age measurements, invokes two different flow systems with different recharge sources to explain the flow within the AMA. One system contains deeply penetrating old water with mean age 10.2 yr and water volume 3 km^3, recharged from the karst uplands. The other, at shallow levels below the valley floor, has much younger water with mean age 1.2 yr and water volume 0.4 km^3, recharged by Upper Takaka River and valley rainfall. The flow systems contribute in different proportions to the Main Spring, Fish Creek Springs and offshore springs. Their very different behaviours, despite being in the same aquifer, are attributed to the presence of a diorite intrusion below the surface of the lower valley, which diverts the deep flow towards the Waikoropupu Springs and allows much of the shallow flow to pass over the intrusive and escape via submarine springs.

Final Revised Paper (PDF, 3521 KB) Discussion Paper (HESSD)

Citation: Stewart, M. K. and Thomas, J. T.: A conceptual model of flow to the Waikoropupu Springs, NW Nelson, New Zealand, based on hydrometric and tracer (^{18}O, Cl, ^{3}H and CFC) evidence, Hydrol. Earth Syst. Sci., 12, 1-19, 2008. Bibtex EndNote Reference Manager