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A multitracer application for the groundwater residence time distribution in the Aladag alpine karstic aquifer (Kayseri-Adana, Turkey)

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The Aladag karstic aquifer of Eastern Taurids Range extends between 400m and 3750m elevations and, covers an area of 1900 km^2within Adana-Kayseri-Nigde provinces. The scope of this study is the Kapuzbasi, Göksu shallow circulation and Yerkopru 1, Yerkopru 2 and Yerkopru 3 deep circulation springs that extend from recharge area to the Zamanti river.

The system is fed by precipitation of Mediterranean origin and total precipitation input, evapo-transpiration, net recharge and its volumetric equivalent are found to be 1113 mm, 451 mm, 879 mm and 939 10^6 m^3. Mean annual discharges of Yerkopru 3, Yerkopru 1 and 2, Göksu and, Kapuzbasi and Barazama springs are 449 10^6 m^3, 82 10^6 m^3, 299 10^6 m^3 and 146 10^6 m^3. Noble gas (^{20}Ne, ^{40}Ar, ^{84}Kr) and ^{18}O isotopes suggest recharge area elevation and temperature ranges of 1700-2100m and 2-6^{o}C. The He content of groundwater increases with increasing circulation depth. Year round biweekly-monthly samples' electrical conductivity, 3H and 18O content reveal that Kapuzbasi and Göksu springs and, Yerkopru 1 and Yerkopru 2 springs behave similarly within themselves.

The "CFC model ages" of the springs where, CFC contents increased from 1997 to 2002, range between 10 to 20 years and 20 to 30 years in the shallow and deep circulation parts, respectively. The ^{3}H/^{3}He* absolute age of groundwater from springs is around 20 +/- 2.5 years. A computer code (LUMPEDUS) was developed for unsteady state lumped parameter modeling applications for which ^{3}H, ^{3}He*, CFC-11, CFC-12, CFC-113, and ^{18}O were used as environmental tracers. Serially connected plug and exponential flow model was applied to all springs. All models were calibrated for ob-

served outflux and their forecasted ^{3}H, ^{3}He* and ^{18}O time series were found to be in good agreement with the observations. Mean residence times found by models are in agreement with ^{3}H/^{3}He* ages. According to residence time distribution suggested by models, most of the discharges comprise of recharge that occurred within last 20 to 30 years. Sixty per cent of discharge comprises of recharge of last 3 to 4 years. The active reservoir volumes of Yerkopru 1-2, Kapuzbasi, Göksu and Yerkopru 3 springs are found to be 1604 10^{6} m^{3}, 2808 10^{6} m^{3}, 5728 10^{6} m^{3} ve 8609 10^{6} m^{3}, respectively. According to well established linear relationship between reservoir volumes and discharge elevations, an active volume increase of 50 10^{6} m^{3} per 1m decrease in elevation. Cumulative active reservoir volume is found to be 18749 10^{6} m^{3} At 450 m elevation where Yerkopru 3 spring is located. Uppermost elevation of active reservoir is located at 836m. Groundwater's velocity ranges between 2.09 m/day and 5.57 m/day and the corresponding hydraulic conductivities for different reservoirs are between 41.8 m/day and 212.2 m/day. The ordering of hydraulic conductivity among springs (Kyerkopru3 $>$ Kyerkopru1-2 $>$ Kgoksu Kkapuzbasi) seems to be related to their time of formation. Based on an assumption of 1500m of maximum hydraulic head at the recharge area, the effective porosity of the system is estimated to be 0.86 per cent.