

Integration of stable isotopes and tracer test to establish the shallow groundwater system in the Tatun Volcano Group (TVG), Taiwan

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Over 200 water samples including rain water, surface water and groundwater from August 2012 to June 2015 in the Tatun volcano group were collected and analyzed. The results show that the isotope composition of surface water are enriched in winter ($\delta^{18}\text{O} = -6.03\text{ ‰}$ $\delta\text{D} = -27.27\text{ ‰}$) and depleted in summer ($\delta^{18}\text{O} = -6.12\text{ ‰}$ $\delta\text{D} = -29.25\text{ ‰}$), indicate that the water mass comes from different sources in summer and winter in the region, respectively. The seasonal variations of groundwaters ($\delta^{18}\text{O} = -5.9\text{ ‰}$ $\delta\text{D} = -28.4\text{ ‰}$) are significant different from that of surface water. This indicates that it takes a significant period of time to have the rain water mixed with groundwater. The main recharge season of groundwater in the northern Cising Mountain is winter while summer is the main recharge season of groundwater in the south of the mountain.

Inter-well natural-gradient tracer tests were conducted in the south and north of Cising Mountain to identify shallow groundwater flow path, respectively. Different tracer breakthrough curves observed from north and south indicate different transport mechanisms may be involved. It took 286 hours for tracer to transport through 860m arriving at Well-17 in the south while 9 hours for tracer to flow through 690m to arrive at Well-30 in the north. Based on borehole properties, we suggest that the groundwater transport is mainly controlled by the formation fractures in the south of Cising Mountain with slower velocity while the groundwater in the north region is dominated by the flow along the boundaries of lava layers with faster velocity. Integrated the stable isotope compositions with tracer tests, we concluded that the major groundwater recharge to the south Cising Mountain region comes from the Caigongkeng Mountain. On the other hand, the groundwater recharge for the north Cising Mountain region primary comes from the Eastern Cising Mountain with minor contribution from the Caigongkeng Mountain.

Keywords: stable isotope, groundwater, tracer test [U+3001] breakthrough curve.