

Groundwater age dating method with CFCs and its application to the springs in volcanic area

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Recently, chlorofluorocarbons (CFCs) concentrations have been used for groundwater dating over timescales of 0-60 years. In the present study, we measured the dissolved CFCs concentrations of spring waters in the volcanic zone, and discuss the residence time of groundwater.

Mt. Fuji, Mt. Yatsugatake and Mt. Ontake in central Japan were selected for the test field. Water samples were collected at the typical springs of each volcano during the wet season in 2006 and dry season in 2007, using the special sampling procedure for CFCs. CFCs were determined in the laboratory using a purge-and-trap gas chromatography procedure with an electron capture detector (ECD).

The results of CFCs measurement show that all springs have detectable concentration of CFC-12, CFC-11 and CFC-113. CFCs concentrations in the springs range from 141 to 2330 pg/kg for CFC-12, from 466 to 12800 pg/kg for CFC-11 and from 41 to 37900 pg/kg for CFC-113. In comparing the CFCs concentration of springs among different volcanoes, the mean values increase in the order of the Mt. Yatsugatake, Mt. Ontake and Mt. Fuji.

Based on the known solubility relationships and the recharge temperature, the CFCs concentration in the springs were converted to the equivalent air concentrations. These concentrations were compared with the atmospheric concentration curve to obtain an apparent CFC age. In some springs, in Mt. Yatsugatake and Mt. Ontake, the individual CFC ages from CFC-12, CFC-11 and CFC-113 agree within the range of several years. In these springs, the estimated mean residence time of groundwater by the piston flow model are from 22 to 29 years in Mt. Yatsugatake and from 15 to 20 years in Mt. Ontake. However, most of the springs in Mt. Ontake, estimated CFC age from CFC-12 were about 10 years younger than that from CFC-11 and CFC-113. This inconsistency might be caused by the addition of excess-air during the recharge process. In Mt. Fuji, because of the high CFCs contamination by the industrial activity, no age information could be assigned, excluding one spring.