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Groundwater system characterized by high chloride concentrations in the central Kanto plain, Japan

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In the central parts of the Kanto plain, confined groundwater with high Cl^- concentrations of up to 216 mg/l is obtained from the productive bores of 200-430 m depth. The area of Cl^- rich groundwater, spreading from the northwest to southeast, corresponds with the so-called Motoarakawa tectonic zone (ca. 10 km wide by 35 km long) bounded by the faults on its longer sides: the Ayasegawa fault on the southwest side and the Kuki fault on the northeast side. It has been found that this Cl^- rich groundwater is characterized by low delta-D and delta-^{18}O values (Yasuhara et al., 2008), and high $^3He/^4He$ ratios and ^4He concentrations (Morikawa et al., 2006). The ^{14}C analyses show very low ^{14}C concentrations of less than 5 pMC for groundwater in the tectonic zone, corresponding to the apparent groundwater residence time of 25,000-30,000 yrs. In contrast, groundwater outside of the tectonic zone has higher ^{14}C concentrations of 20-90 pMC indicative of the shorter residence time. Morikawa et al. (2006) showed that a strong correlation exists between the Cl^- and ^4He concentrations, indicating groundwater in the tectonic zone is a result of mixing of water with Cl-poor, shorter residence time and that of Cl-rich, longer residence time. Yasuhara et al. (2008) also found that groundwater in the tectonic zone results from a mixing between the Cl-rich (75-200 mg/l), low delta-D (ca. -73 permil) water and the Cl-poor (ca. 10 mg/l), high delta-D (ca. -60 permil and more) water.
Taking all hydrologic data obtained so far into account, with regard to the origin of the groundwater in the Motoarakawa tectonic zone, a potential source is assumed to be precipitation of low stable isotopic composition in the Last Glacial Maximum when the sea level of the Tokyo Bay was lower than the present by more than 100 m. Admixture of sea water in the periods of the Nanagochi (15,000-11,000 yrs. BP) and Jomon (10,000-5,500 yrs. BP) transgressions is likely to account for its elevated Cl^- concentrations. The Ayasegawa and Kuki faults, and other unknown faults can act as a geologic barrier to the modern groundwater flow system, preventing the mixing of groundwater in and out of the tectonic zone.

Keywords: Kanto plain, Motoarakawa tectonic zone, isotopes, water chemistry, groundwater system