Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HTT32-P10 Room:Convention Hall Time:May 23 18:15-19:30

Characteristic features of chemical compositions and isotopic ratios of river water in Akita Prefecture

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Chemical compositions and isotopic ratios of river water in Akita Prefecture were examined for samples collected in the base-flow period from October to December in 2011 at 125 sites. All water samples were filtered through disposable cellulose acetate filters with a pore size of 0.2 micrometer. Chemical analyses were performed at the Research Institute for Humanity and Nature. The concentrations of dissolved components in the water were determined by means of inductively plasma mass spectrometry (Agilent 7500cx) and an ion chromatograph (Dionex ICS3000), respectively. We determined H and O isotope ratios using Cavity Ringdown Spectrometer (Picarro L2120-i), and Sr isotope ratios by using a thermal ionization mass spectrometer (Thermo Fisher TRITON). The geographical distribution of water quality component was analyzed using Arc-GIS of EERI.

Geology of Akita Prefecture mainly consists of Neogene and Quaternary strata. Quaternary volcanic rocks cover the Neogene strata in the eastern part of Akita Prefecture along Ou Mountains. Sedimentary strata in Neogene tend to be distributed in the western part of the prefecture.

Acidic river waters are distributed in areas in the eastern part of Akita Prefecture in which there are Quaternary volcanoes and acidic hot springs with magmatic components. Acidic river waters characterized by occurrence of abundant mines are also distributed in the central part of the prefecture. Cl^- and $SO_4{}^{2-}$ concentrations are high in river water in areas along Ou Mountains consisting of Quaternary volcanic rocks and along the coast of the Sea of Japan (coast of Akita Prefecture). The high concentrations of Cl^- and $SO_4{}^{2-}$ are due to effects of acidic thermal water and sea salt particles. F^- concentration is high in river flowing from Hachimantai and Kurikoma areas of Ou Mountains. The high F^- concentration is traced from Ou Mountains to the Sea of Japan for over 100 km along the Omono river system. $NO_3{}^-$ concentration is high in river water in flat plains for agriculture in Akita Prefecture.

Na and K concentrations are high in rivers along the coast of Akita Prefecture, Kurikoma area in the southeastern part of the prefecture and Ohdate area in the northeastern part of the prefecture. The high Na and K concentrations in rivers along the coast of Akita Prefecture and Kurikoma area are caused by sea salt particles and acidic thermal water, respectively. River water having high Na and K concentrations in Ohdate area is characterized by high Mg, Cl^- and $SO_4{}^{2-}$ concentrations. These facts suggest that fossil seawater from hot springs was mixed with normal river water. The distribution of river water having a high Ca content overlaps with the distribution of river water having a high $SO_4{}^{2-}$ content in the area of Quaternary volcanic rocks along Ou Mountains. The high Ca content is thought to be a result of water/rock interaction between volcanic rocks and $SO_4{}^{2-}$-bearing ground water formed by oxidation of sulfide minerals in volcanic rocks.

Hydrogen and oxygen isotopic ratios of river water in Akita Prefecture tend to be heavier in the coastal area of the prefecture and lighter in the eastern part of the prefecture along the Ou Mountains. Hydrogen and oxygen isotopic ratios of river water are also heavier in the area from Yokote to Daisen Cities with a northwest to southeast direction. The d-values of hydrogen and oxygen isotopic ratios are higher in river water in Hachimantai-Moriyoshi and Kurikoma areas, which have large annual snow accumulation.

The effects of sea salt particles, thermal water, mine drainage water, and water/rock interaction between Neogene and Quaternary strata and ground water control the chemical compositions of river water in Akita Prefecture.

Keywords: water quality, geochemical map, Akita, mine, hot spring, river water