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The chemical evolution of glacier-sourced surface water in southern Iceland

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Iceland has several large glaciers, which feed the surrounding groundwater, huge rivers and numerous streams. Among all, the Vatnajoekull glacier, located at southeastern Iceland, is the largest in Europe. Its thickness is 400 m on average and 1100 m at the thickest point, and its coverage reaches up to 8200 km^3, about 8 % of the country. All the glaciers cover 10 % and are evaluated as long-lasting water resources. These huge reservoirs have been supported by the Global Ocean Thermohaline Circulation which submerges around the Labrador Sea and supplies annual 800 mm precipitation in Iceland.

Since elevated parts of the Mid-Atlantic Ridge expose the island above sea level, Iceland has a number of volcanoes even under the glaciers. Subglacial volcanism makes volcanologically, geographically and hydrologically unique features in Iceland. A 'joekulhlaup' is one of the most distinguished phenomena. A joekulhlaup is an Icelandic term, meaning a subglacial outburst flood triggered by a subglacial eruption. The most renowned one was caused by the 1996 eruption of Grimsvoetn under the Vatnajoekull glacier. The intensive flow of ice-melt water washed out highways and architectures into the sea a few kilometers offshore and accumulated incredible amount of fine-grained basalt sand (several cubic kilometers in a few days). Since joekulhlaups have often occurred in historic and prehistoric times (e.g., 100 times in recent 800 years in case of Grimsvoetn), their deposits now cover quite vast areas in southern Iceland (the so-called 'sandur' areas in Icelandic).

In August, 2008, water samples were collected from rivers and streams running through several joekulhlaup sandurs originated from the Vatnajoekull, Eyjafjallajoekull or Myrdalsjoekull glaciers. Also collected were glacier-melt waters from several glacial lakes (e.g., the Skeidararjoekull and Joekulsarlon glacial lake, both of which are tongues of Vatnajoekull), since they are supposed to be the source of the collected river waters. Then the concentrations of major ions and the isotopic ratios of hydrogen and oxygen were analyzed.

The dD versus $d^{18}O$ diagram shows that the data are aligned along a linear trend. The obtained fitted line, the so-called local meteoric water line, is $dD = 7.66\ d^{18}O + 7.15$, which clearly reflects the distance from the seashore. The lightest dD and $d^{18}O$ (i.e., dD = - 84.6 per mil, $d^{18}O$ = - 12.0 per mil vs. SMOW) are obtained by the ice-melt water of the Skeidararjoekull glacial lake. Starting with this ice-melt water without being suffered by water-rock interaction, it may be possible to trace the chemical evolution of surface water interacting with surrounding bedrocks (mainly basalts). Since the temperature of the glacier-sourced river water is distinctly lower (about 3 to 5 degC) than that of the long-accumulated groundwater (about 10 degC, nearly the same as the annual mean temperature in southern Iceland), the temperature of the sampled water could be one of the effective tracers. Therefore together with these markers, the formation and evolution of the water properties interacted with basalts will be discussed.