United States Geological Survey

Reston Stable Isotope Laboratory

Report of Stable Isotopic Composition

Reference Material USGS47

Lake Louise Drinking Water

(Hydrogen and Oxygen Isotopes in Water)

This reference material (RM) is intended for daily normalization of stable hydrogen-isotope (δ^2H) and oxygen-isotope (δ^{18}O) measurements of unknown waters with an isotope-ratio mass spectrometer or a laser absorption spectrometer. A unit of this RM consists of 144 autoclaved glass ampoules of Lake Louise water. Glass ampoules containing 5 mL of water are available.

Recommended Values: Stable hydrogen and oxygen isotopic compositions are expressed herein as delta values [1] relative to VSMOW (Standard Mean Ocean Water) on scales normalized such that the δ^2H and δ^{18}O values of SLAP (Standard Light Antarctic Precipitation) are –428 ‰ and –55.5 ‰, respectively [2,3]. Each stable isotopic composition is given as a reference isotope-delta value with an estimated expanded uncertainty ($U = 2u_c$) about the reference value that provides an interval that has about a 95-percent probability of encompassing the true value [4].

Stable hydrogen isotopic composition: $\delta^2H_{VSMOW\text{-}SLAP} = -150.2 \pm 0.5$ ‰

Stable oxygen isotopic composition: $\delta^{18}O_{VSMOW\text{-}SLAP} = -19.80 \pm 0.02$ ‰

Technical coordination for this RM was provided by Haiping Qi of the Reston Stable Isotope Laboratory (RSIL).

Reston, Virginia 20192
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Expiration of Reference Value: The reference values for the isotopic composition of USGS47 are valid until December 31, 2034, provided the RM is handled in accordance with the instructions given in this Report of Stable Isotopic Composition (see "Instructions for Use"). A reference value is nullified if the glass ampoule containing the RM is inadvertently broken.

Source of the RM: About 400 L of drinking water was collected with the assistance of Bernhard Mayer and Steve Taylor (Department of Geoscience, University of Calgary, Calgary Alberta, Canada) from the Fairmount Chateau Lake Louise (Fig. 1). The tap water was filtered, chlorinated, and treated with ultraviolet radiation at the drinking water treatment plant of Chateau Lake Louise. At the RSIL, half of the water was filtered with a 0.45-µm filter, homogenized, loaded into 5-mL glass ampoules, and sealed with a torch. Each ampoule was inverted and autoclaved at about 120 °C for a minimum of 20 minutes to terminate biological activity. Each ampoule was weighed to identify and eliminate any leaking ampoules.

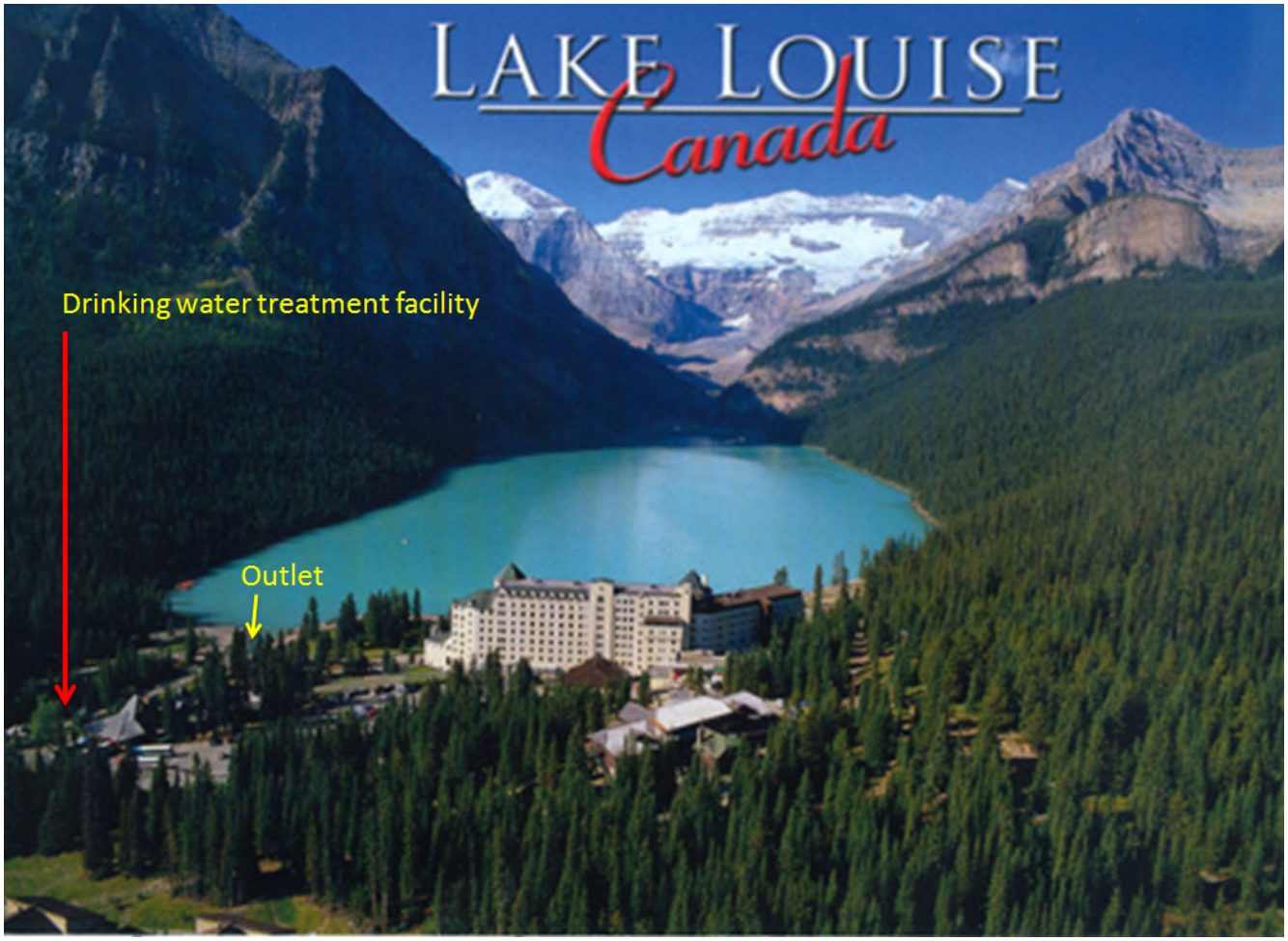

Figure 1. Fairmount Chateau Lake Louise is shown in the center of the picture and is the site from which USGS47 Lake Louise Drinking Water was obtained. The outlet of Lake Louise, shown by an arrow in yellow flows to the drinking water treatment facility where it is filtered, chlorinated, and treated with ultraviolet radiation.

Stability: USGS47 is stable at normal room temperatures. The reference values in this Report of Investigation apply only to freshly opened ampoules.

Instructions for Use: This RM is intended for daily calibration of instrumentation and for calibrating unknown waters by interspersing aliquots of the RM among water sample unknowns. The unused fraction of this RM should be discarded after opening an ampoule due to the strong possibility of evaporative losses causing significant isotopic fractionation. It is envisioned that laboratory personnel will open an aliquot of USGS47 daily and they analyze their unknown waters. Laboratory personnel can use two different water RMs (others include USGS45, USGS46, and USGS48) and then normalize isotopic measurement results to the VSMOW-SLAP scale [5]. Many users employ LIMS for Light Stable Isotopes for their normalization [6].

Reporting of Stable-isotope-delta Values: The following recommendations are provided for reporting stable hydrogen and oxygen isotope-delta values [3]. It is recommended that:

- The δ^2H values of all hydrogen-bearing substances be expressed relative to VSMOW-SLAP on a scale where δ^2H_{SLAP} = –428 ‰ exactly or δ^2H_{SLAP2} = –427.5 ‰ [7].
- The δ^{18}O values of all oxygen-bearing substances be expressed relative to VSMOW-SLAP or relative to Vienna Peedee belemnite (VPDB; for carbonates) on a scale such that the δ^{18}O of SLAP = –55.5 ‰ relative to VSMOW, and for carbonates, such that δ^{18}O of NBS 19 calcium carbonate = –2.2 ‰.
- Authors report δ values of international distributed (secondary) isotopic reference materials as though they had been interspersed among and used for normalization of unknowns, as appropriate, for the measurement method. In this manner, measurement results can be adjusted in the future as analytical methods improve and consensus values of internationally distributed isotopic reference materials change.
- Reporting of δ values relative to SMOW and PDB (Peedee belemnite) be discontinued [8].

REFERENCES

[1] Coplen, T. B., 2011, Guidelines and recommended terms for expression of stable-isotope-ratio and gas-ratio measurement results: Rapid Communications in Mass Spectrometry, v. 25, 2538–2560, (last accessed November 7, 2014 at http://onlinelibrary.wiley.com/doi/10.1002/rcm.5129/abstract).

[2] Gonfiantini, R., 1978, Standards for stable isotope measurements in natural compounds: Nature, v. 271, p. 534–536.

[3] Coplen, T. B., 1994, Reporting of stable hydrogen, carbon, and oxygen isotopic abundances: Pure and Applied Chemistry, v. 66, p. 273–276.

[4] Qi, H., Lorenz, J., Coplen, T. B., Tarbox, L., Mayer, B., and Taylor, S., 2014, Lake Louise Water (USGS47): A new isotopic reference water for stable hydrogen and oxygen isotope measurements: Rapid Communications in Mass Spectrometry, v. 28, 351–354, (last accessed November 7, 2014 at http://dx.doi.org/10.1002/rcm.6789).

[5] Coplen, T. B., 1988, Normalization of oxygen and hydrogen isotope data: Chemical Geology (Isotope Geosciences Section), v. 72, p. 293–297.

[6] LIMS for Light Stable Isotopes, http://isotopes.usgs.gov/research/topics/lims.html .

[7] International Atomic Energy Agency (IAEA), Reference Sheet for International Measurement Standards, http://nucleus.iaea.org/rpst/Documents/VSMOW2_SLAP2.pdf (last accessed August 2012).

[8] Coplen, T. B., 1995, Discontinuance of SMOW and PDB: Nature, v. 375, 285.