United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192
431 National Center

February 22, 2006

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Dear Dr. Abdullayev:

The Reston Stable Isotope Laboratory has analyzed the following samples received from you for isotopic analysis.

We analyzed each of your samples once and we analyzed the hydrogen equilibrated with sample twice. Thus, there are four analyses.
Sample 1
-985.6 per mill
-984.4 per mill
Mean = -985.0 per mill

Sample 2
-985.4 per mill
-984.5 per mill
Mean = -984.9 per mill

The hydrogen isotopic compositions are reported relative to VSMOW water on a scale such that the hydrogen isotopic composition of SLAP reference water is -428 per mill. The precision of these analyses is reasonably good at approximately ±0.7 per mill, but we are uncertain about the uncertainty on the accuracy of the mean values on the VSMOW-SLAP scale because these samples contain so little deuterium. I would not be surprised if the "true" mean values were off by 2 or 3 per mill or so. Without a lot of work, this would be difficult for us to quantity.

Methods
Since May 1, 1990, hydrogen-isotope-ratio analyses have been performed using a hydrogen equilibration technique (Coplen and others, 1991; Revesz and Coplen, 2003a), rather than the zinc technique used prior to that date (Kendall and Coplen, 1985). The hydrogen equilibration technique measures deuterium activity, whereas the zinc technique measures deuterium concentration. For the majority of WRD samples, the difference in reported isotopic compositions between the two techniques is not significant. However, in brines, the difference

may be significant (Sofer and Gat, 1972, 1975). Reported delta H-2 values of activity are more positive than delta H-2 values of concentration, and this difference is proportional to molalities of the major dissolved solids. Some examples of the differences between activity ratios and concentration ratios for delta H-2 in 1 molal salt solutions are as follows (Horita and others, 1993). The data for individual salts may be multiplied molality to obtain adjustments to delta values based on concentration.

Solution (1 molal)	Delta H-2 (activity) - Delta H-2 (conc.) (30 degrees C)
NaCl	+2.07 per mill
KCl	+2.42 per mill
CaCl2	+5.31 per mill
MgSO4	+1.12 per mill

References

Coplen, T. B., 1994. Reporting of Stable Hydrogen, Carbon, and Oxygen Isotopic Abundances, Pure and Applied Chemistry, v. 66, p. 273-276.

Coplen, T. B., Wildman, J. D. and Chen, J., 1991. Improvements in the Gaseous Hydrogen-Water Equilibration Technique for Hydrogen Isotope Ratio Analysis, Analytical Chemistry, v. 63, p. 910-912.

Horita, J., Wesolowski, D., and Cole, D., 1993. The activity-composition relationship of oxygen and hydrogen isotopes in aqueous salt solutions: I. Vapor-liquid water equilibration of single salt solutions from 50 to 100° C, Geochim. Cosmochim. Acta, v. 57, p. 2797-2817.

Kendall, C. and Coplen, T.B., 1985. Multisample Conversion of Anal. Chem. v. 57, p. 1437-1440.

Sofer, Z. and Gat, J. R., 1972. Activities and concentrations of oxygen-18 in concentrated aqueous salt solutions: analytical and geophysical implications. Earth Planetary Science Letters, v. 15, p. 232-238.

Sofer, Z. and Gat, J. R., 1975. The isotope composition of evaporating brines: Effect of the isotopic activity ratio in saline solutions. Earth Planetary Science Letters, v. 26, p. 179-186.

Sincerely,

Tyler B. Coplen
Research Chemist