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Introduction

A local meteoric water line (LMWL) was established for Madison, WI using precipitation samples collected between August, 1998 and November, 1999. The work was completed as part of a larger study of the Nine Springs watershed in Fitchburg and Madison, WI, under Wisconsin Department of Natural Resources (WDNR) grant no.s NMH00000183 and NMI00000261. Preliminary results were included in a final report submitted to the WDNR entitled *Groundwater-Surface Water Interactions in the Nine Springs Watershed* (Bahr and others, 1999). Final results are presented here.

Background

Stable isotopes of oxygen and hydrogen are measured as a ratio of the two most abundant isotopes of each element. Isotopic concentrations are expressed as the difference between the measured ratios of a sample and a standard over the measured ratio of the standard. They are reported as parts per thousand (‰) using the del (δ) notation where

$$\delta_{sample} = \frac{(R_{sample} - R_{standard})}{R_{standard}} * 1000 ,$$

and $R_{sample} = {}^{18}\text{O}/{}^{16}\text{O}$ or ${}^2\text{H}/{}^1\text{H}$ in the sample and $R_{standard}$ is the ratio of the international standard for oxygen or hydrogen, VSMOW (Vienna Standard Mean Ocean Water) (Clark and Fritz, 1997).

A plot of $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ can be used to clarify groundwater sources and investigate secondary processes like evaporation (Clark and Fritz, 1997). Craig (1961) showed that values of $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ for global precipitation and surface water samples show a linear relationship, which he defined as the global meteoric water line (GMWL), $\delta^2\text{H} = 8\delta^{18}\text{O} + 10\text{‰}$. Local meteoric water lines (LMWL) differ from the global line due to local climatic and

geographic characteristics. Partitioning of groundwater samples along the LMWL for a region can provide information on groundwater recharge environments or seasonality. Groundwater and surface water samples that plot off the LMWL carry information that can be used to infer processes that cause fractionation of isotopes, such as evaporation (Clark and Fritz, 1997).

The Local Meteoric Water Line for Madison, WI

A LMWL for Madison, WI was established on the basis of precipitation samples collected at Weeks Hall on the campus of the University of Wisconsin – Madison between August, 1998 and November, 1999 (Figure 1).

$$\delta^2H = 7.79\delta^{18}O + 13.1\text{‰}$$

The water samples used to create the LMWL were analyzed by mass spectrometry at the Southern Methodist University Stable Isotope Laboratory (Table 1). All but three are composite monthly precipitation samples (Table 2). The samples were created from waters collected during individual precipitation events, but they were combined in volumes that are proportional to precipitation levels that fell during that month. The monthly and daily precipitation data used to calculate appropriate volumes are those recorded for the Dane County Regional Airport. The precipitation data are available from NOAA’s National Climatic Data Center.

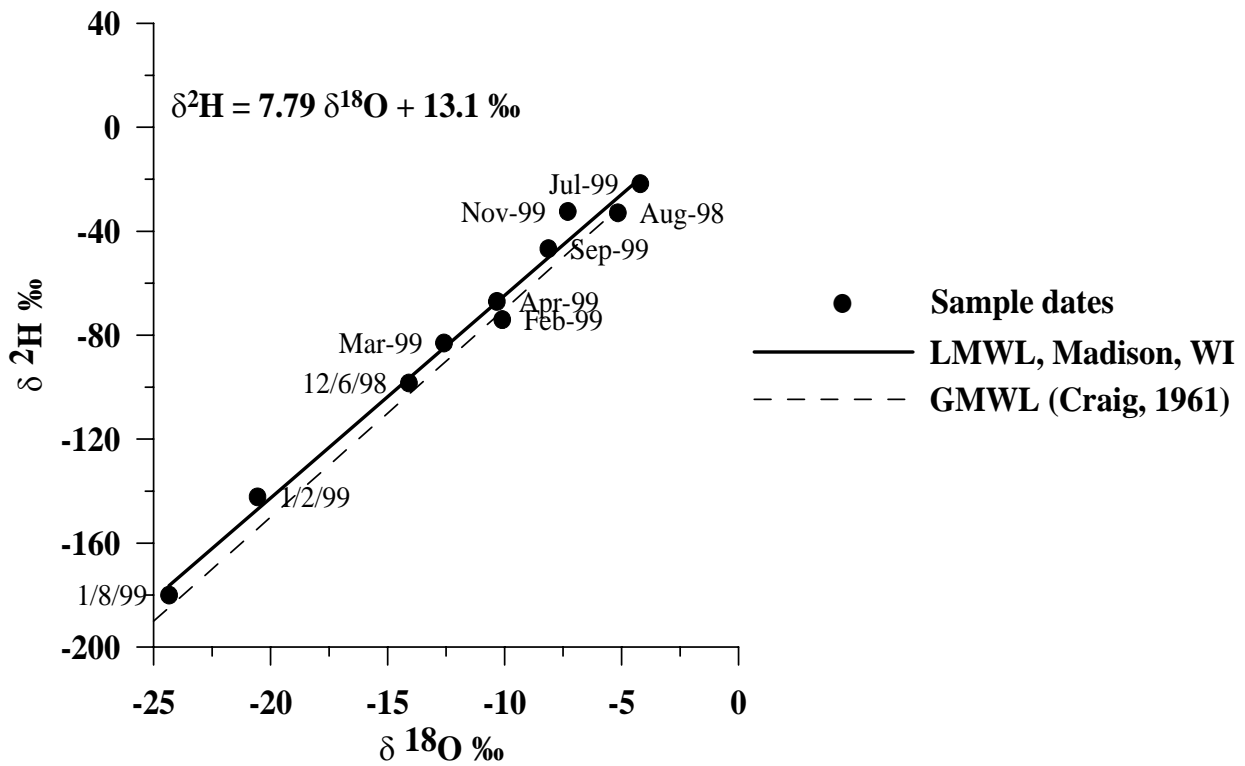


Figure 1. Local meteoric water line for Madison, WI

Table 1. Stable isotope results for precipitation samples collected in Madison, WI

Date	Composite Sample	d ¹⁸ O	Repeat	d ² H	Repeat
Nov-99	x	-7.30		-32.4	
Sep-99	x	-8.13		-46.7	-46.0
Jul-99	x	-4.20	-4.19	-21.7	
Apr-99	x	-10.33		-67.0	
Mar-99	x	-12.59	-12.58	-83.0	-81.2
Feb-99	x	-10.10		-74.0	
1/8/99		-24.34		-180.0	
1/2/99		-20.56	-20.41	-142.2	-143.1
12/6/98		-14.09		-98.4	
Aug-98	x	-5.16		-32.9	

Table 2. Summary of composite precipitation samples

Composite Sample Dates	Total Precipitation ¹ (inches)	Snowfall ¹ (inches)	Volume (ml)	Total Volume sent for analysis (ml)
Nov-99				25.0
11/23-24/99	0.85		25.00	
Sep-99				25.0
9/26-28/99	1.47		25.00	
Jul-99				25.0
7/13-14/99	0.04		0.25	
7/16-20/99	2.36		17.00	
7/21/99	0.10		0.75	
7/23/99	0.01		0.01	
7/26/99	0.26		1.75	
7/31/99	0.71		5.00	
Apr-99				25.0
4/3-5/99	1.33		5.00	
4/8-9/99	1.76		6.50	
4/20-23/99	3.50		12.75	
4/27/99	0.21		0.75	
Mar-99				25.0
3/5/99	0.09	1.7	5.80	
3/8-9/99	0.30	5.8	19.20	
Feb-99				25.0
2/11/99	0.51		18.75	
2/24/99	0.17		6.25	
Aug-98				25.0
8/3-6/99	2.68		25.00	

Notes:

¹ Local climatological data for the Dane County Regional Airport from NOAA. When snowfall was measured, water equivalent as reported by NOAA is listed for total precipitation.

References:

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