Using Chloride Mass Balance to Quantify Groundwater Recharge in the Mountains of New Mexico

David Ketchum, NM Tech, master's degree student,
and NM WRRI Student Water Research Grant recipient

David Ketchum is a native of Bradford, Vermont. He did his undergraduate work in geography at Western Washington University in Bellingham, Washington, with a focus on natural resource management. After working as a nature guide in Chile for six years, he returned to study hydrology at New Mexico Tech, where he is now nearing the completion of his master's degree. David's hydrology work focuses on simulating the statewide soil water balance in New Mexico using high resolution remote sensing inputs. David is bound for Montana, where he will join the State Water Bureau and begin a remote sensing program focused on estimating irrigation requirements and crop water consumption. David is also a recipient of an FY 16 NM WRRI Student Water Research Grant.

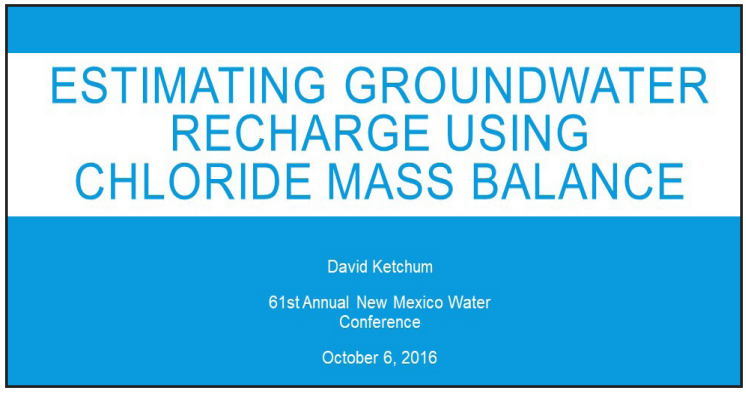

Figure 1. Introduction.

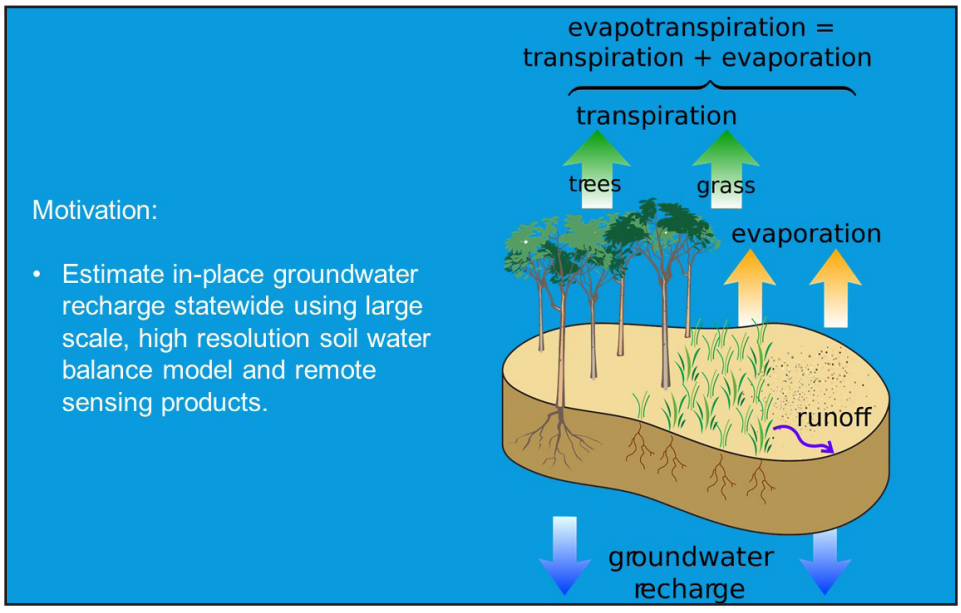

Figure 2. Motivation behind estimating groundwater recharge.

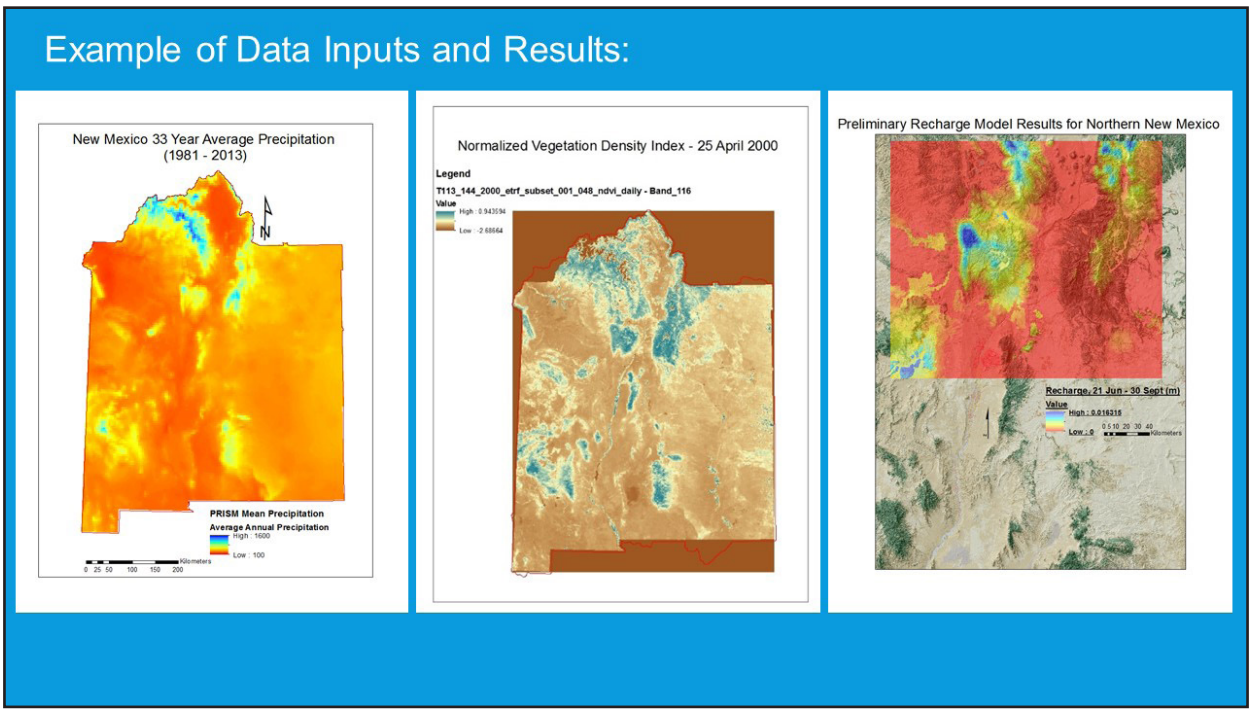

Figure 3. Data inputs and results.

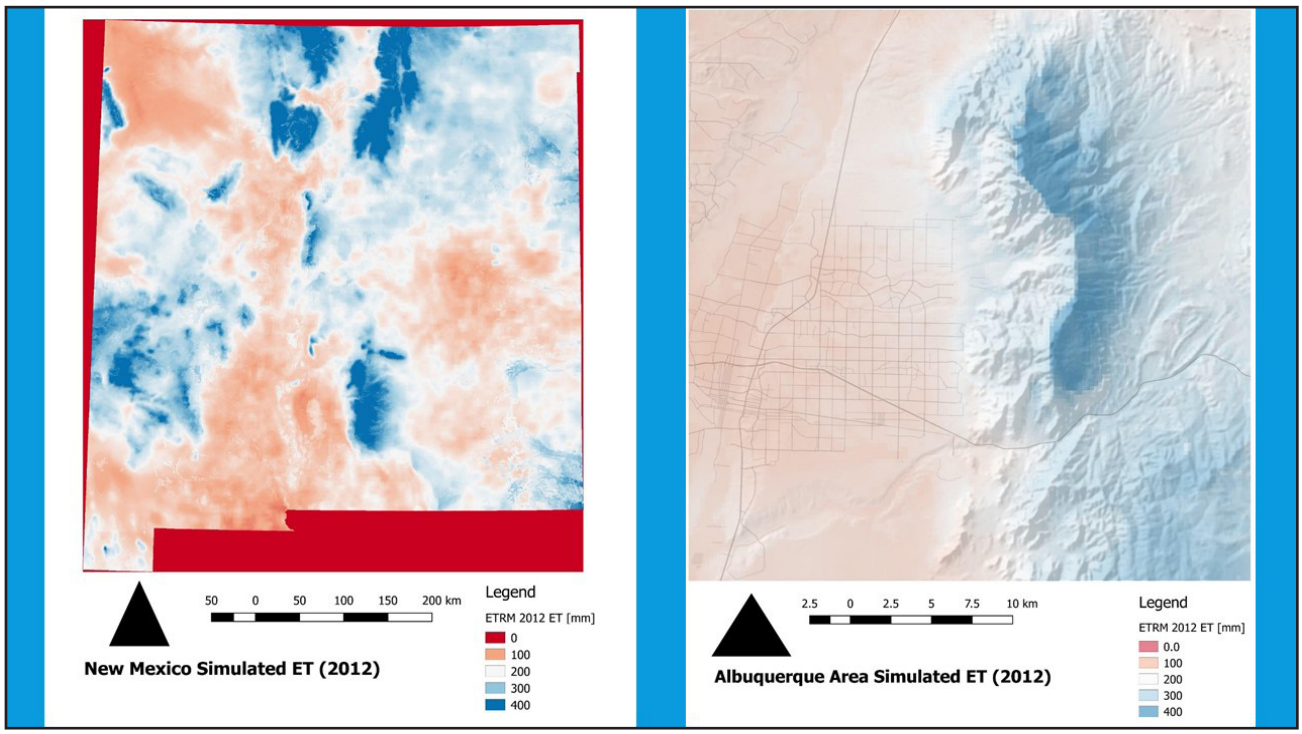

Figure 4. Simulated evapotranspiration for New Mexico and Albuquerque in 2012.

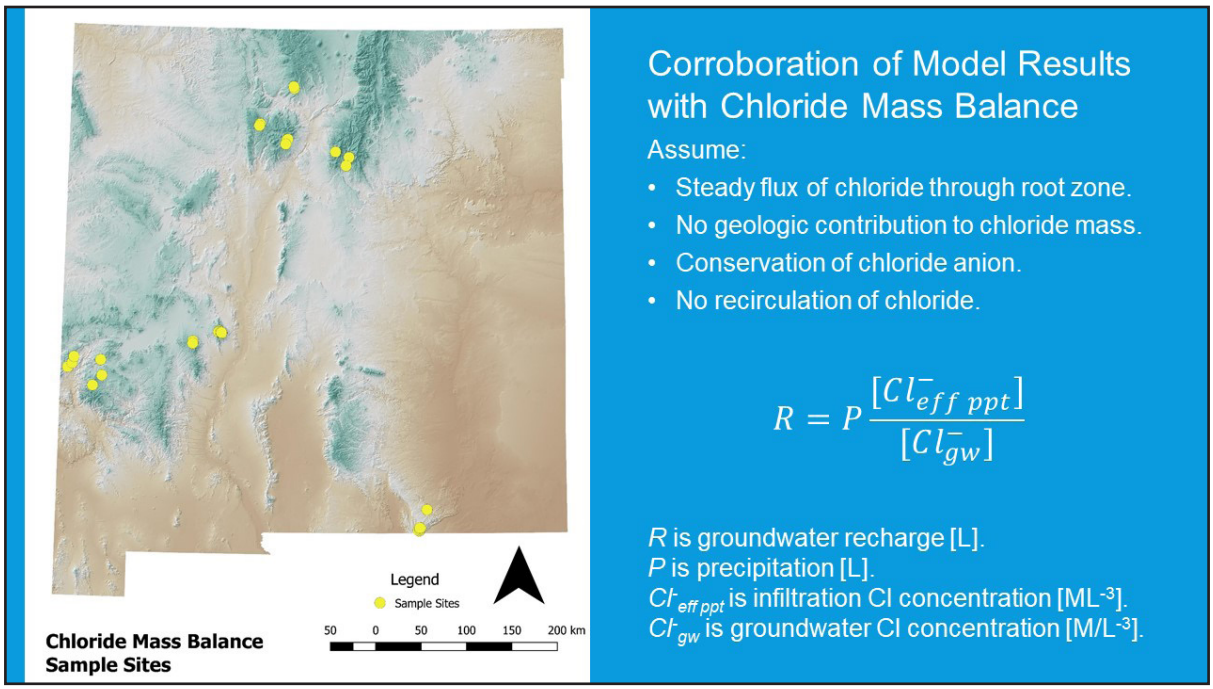

Figure 5. Corroboration of model results with chloride mass balance.

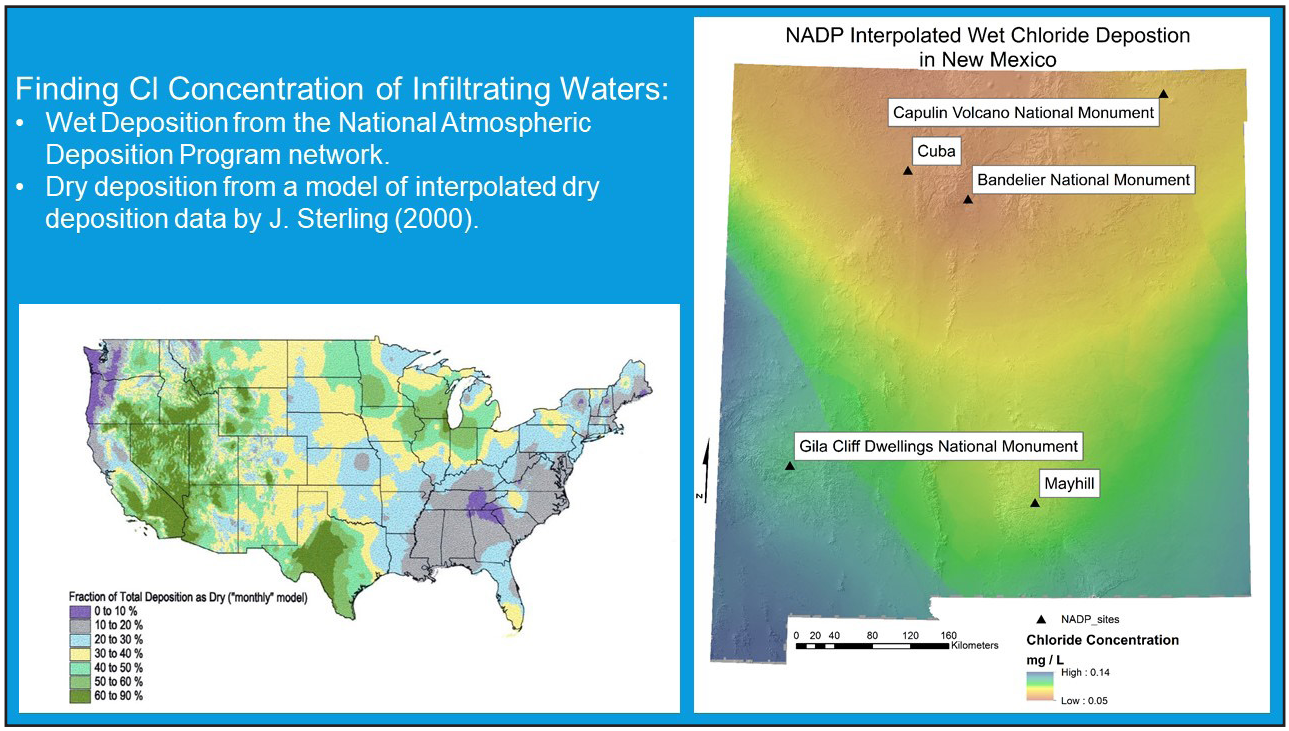

Figure 6. Finding chlorine concentration of infiltrating waters.

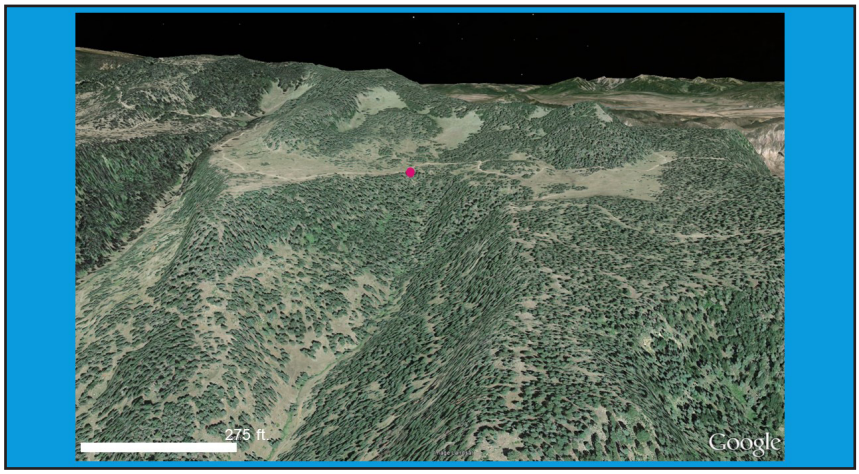

Figure 7. Sites of springs where water was collected for stable isotope analysis in the San Pedro, Sangre de Cristo, and Guadalupe mountains.

Figure 8. Sites of springs where water was collected for stable isotope analysis in the San Pedro, Sangre de Cristo, and Guadalupe mountains (cont.).

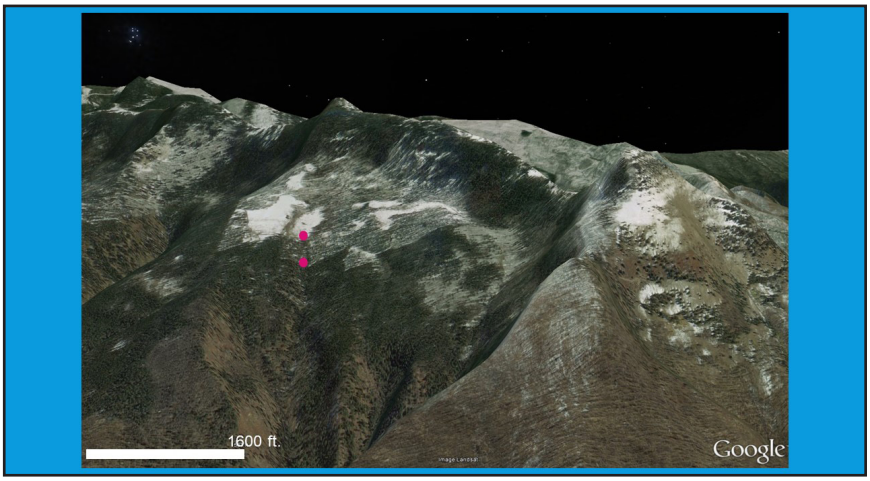

Figure 9. Sites of springs where water was collected for stable isotope analysis in the San Pedro, Sangre de Cristo, and Guadalupe mountains (cont.).

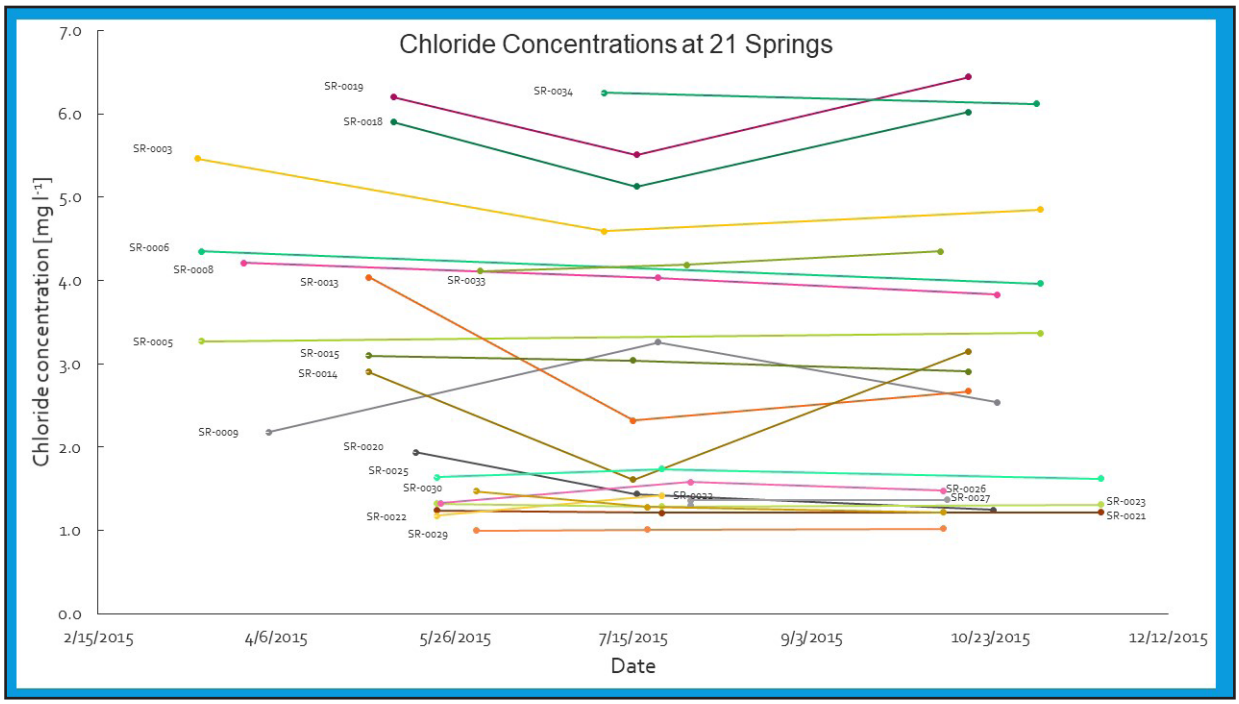

Figure 10. Chloride concentrations at 21 springs.

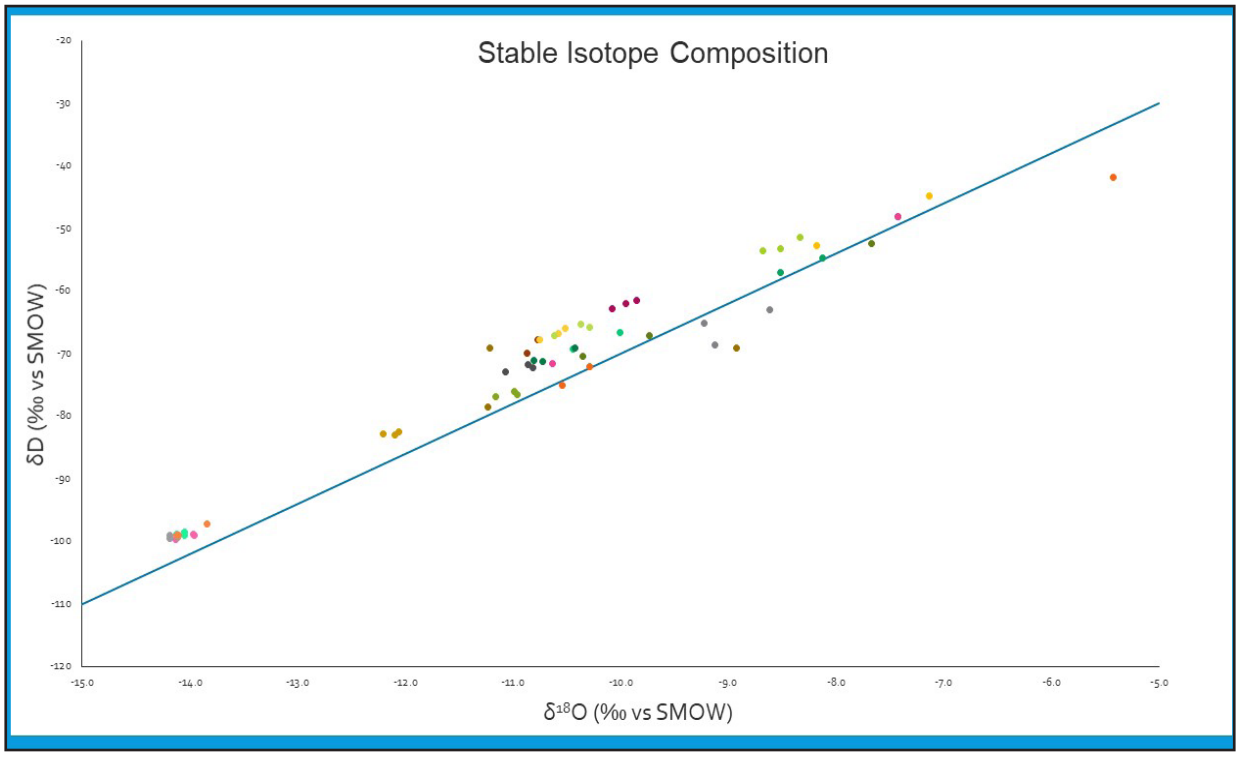

Figure 11. Stable isotopic composition of waters used in this study.

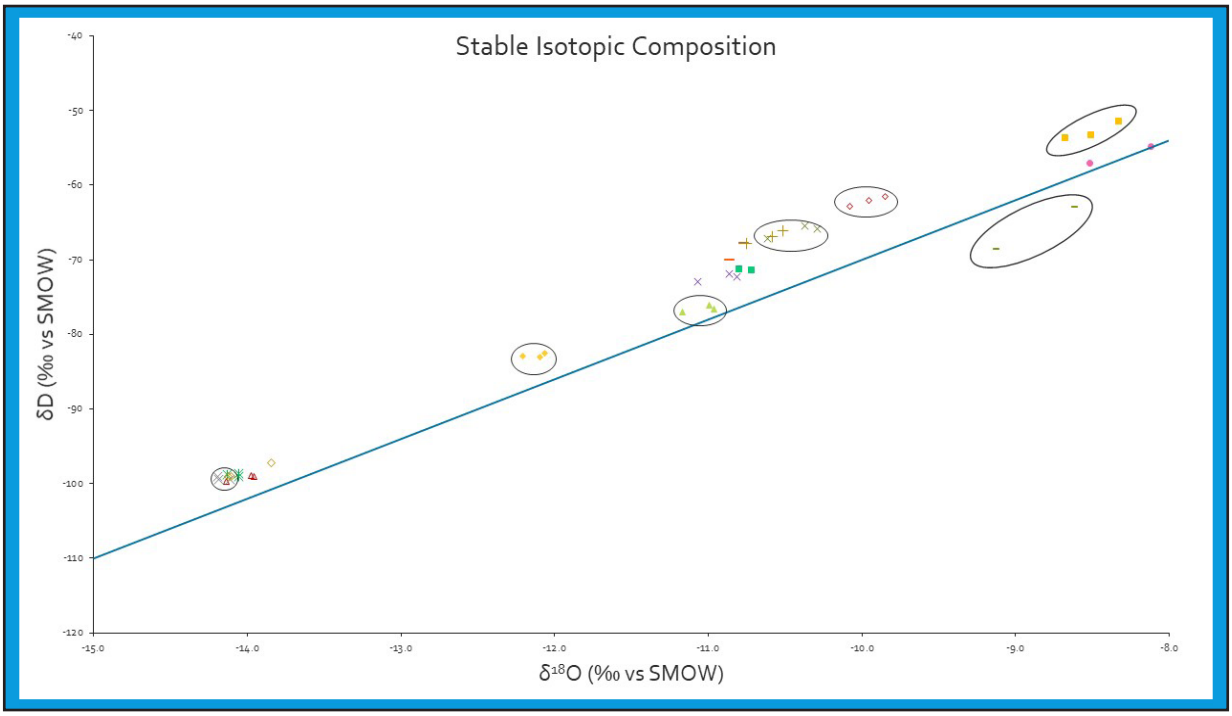

Figure 12. Stable isotopic composition of spring waters, grouped by location.

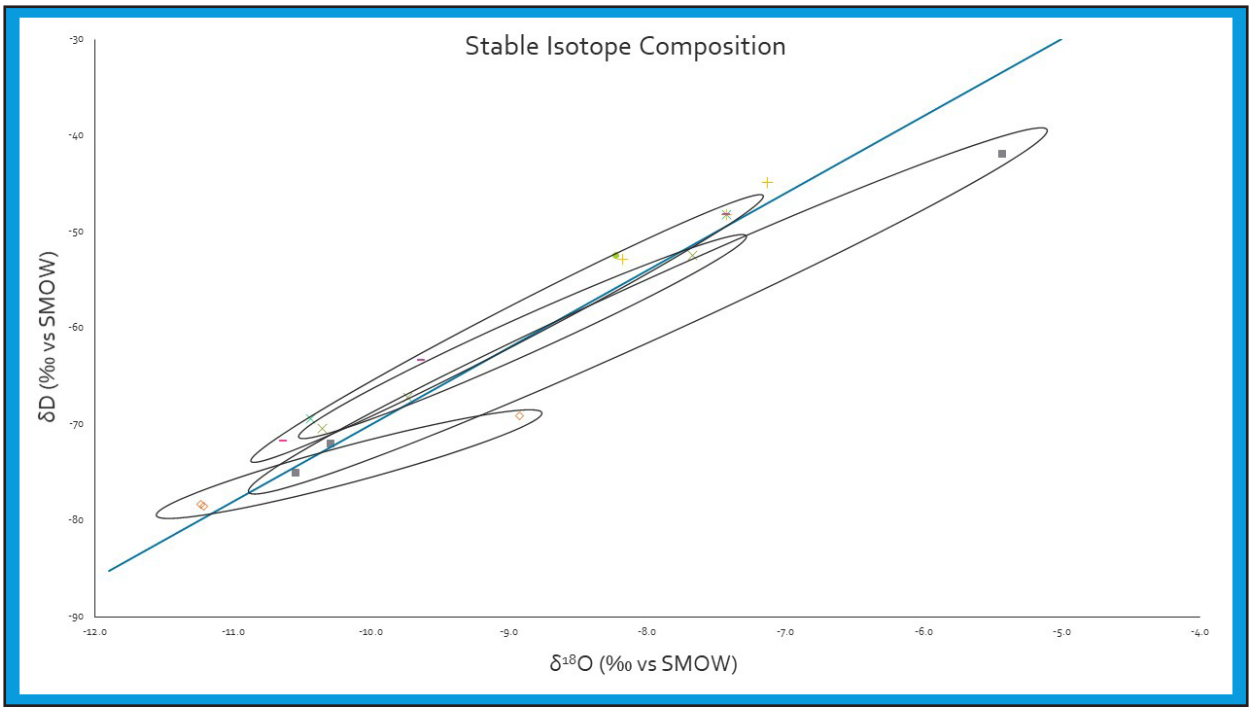

Figure 13. Stable isotopic composition of spring waters, grouped by location (cont.).

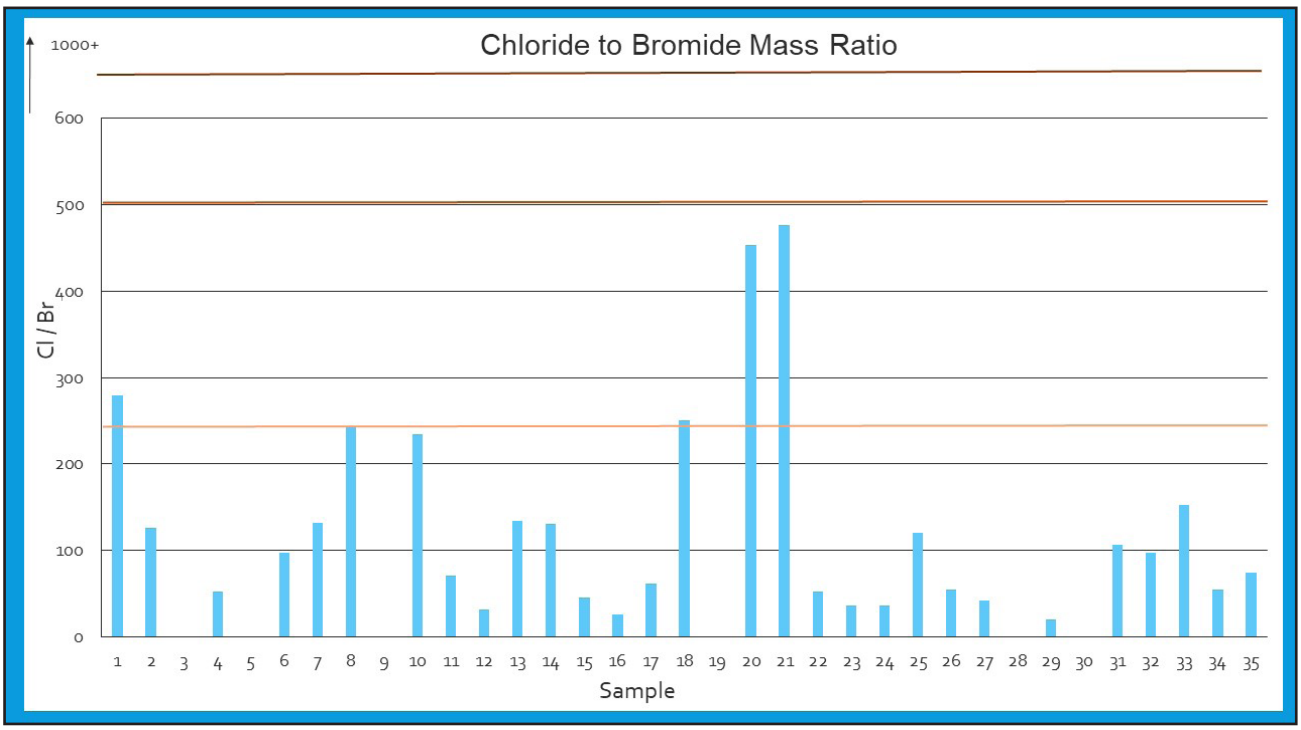

Figure 14. Chloride to bromide mass ratio.

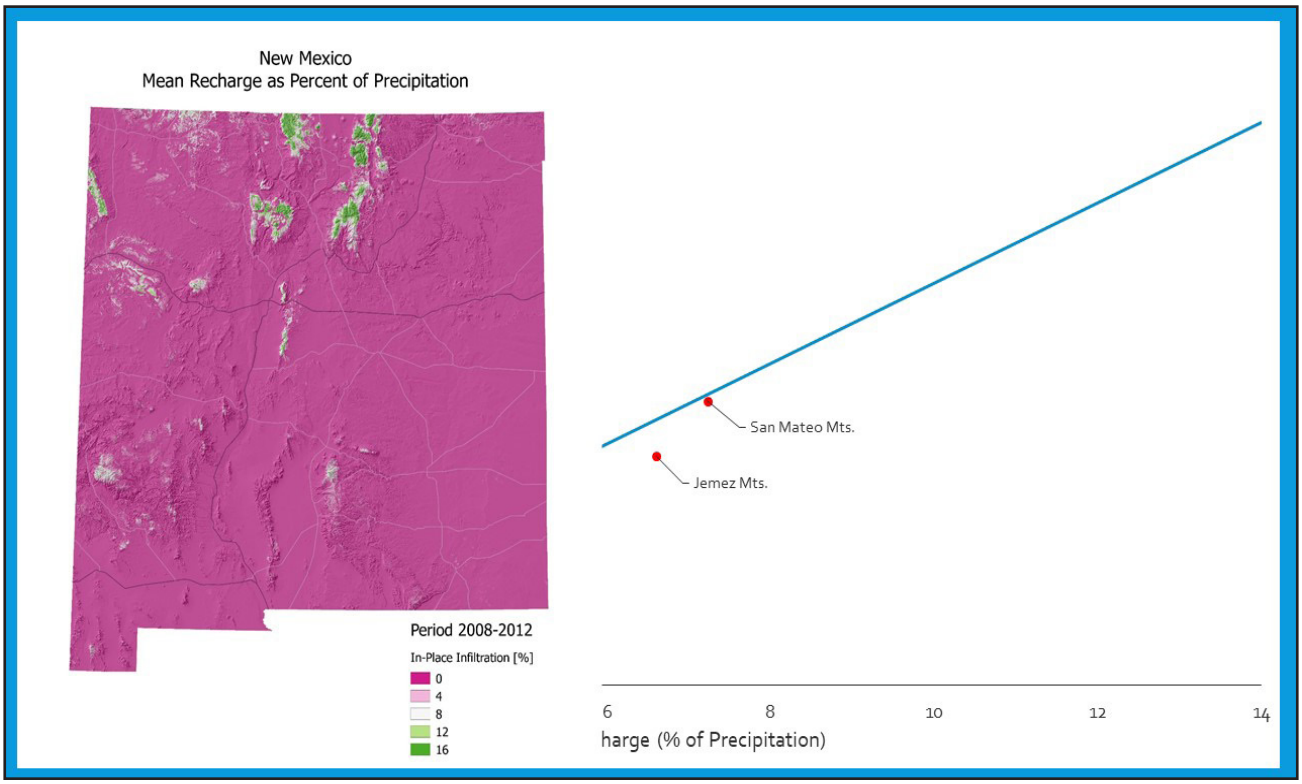

Figure 15. New Mexico mean recharge as percent of precipitation.

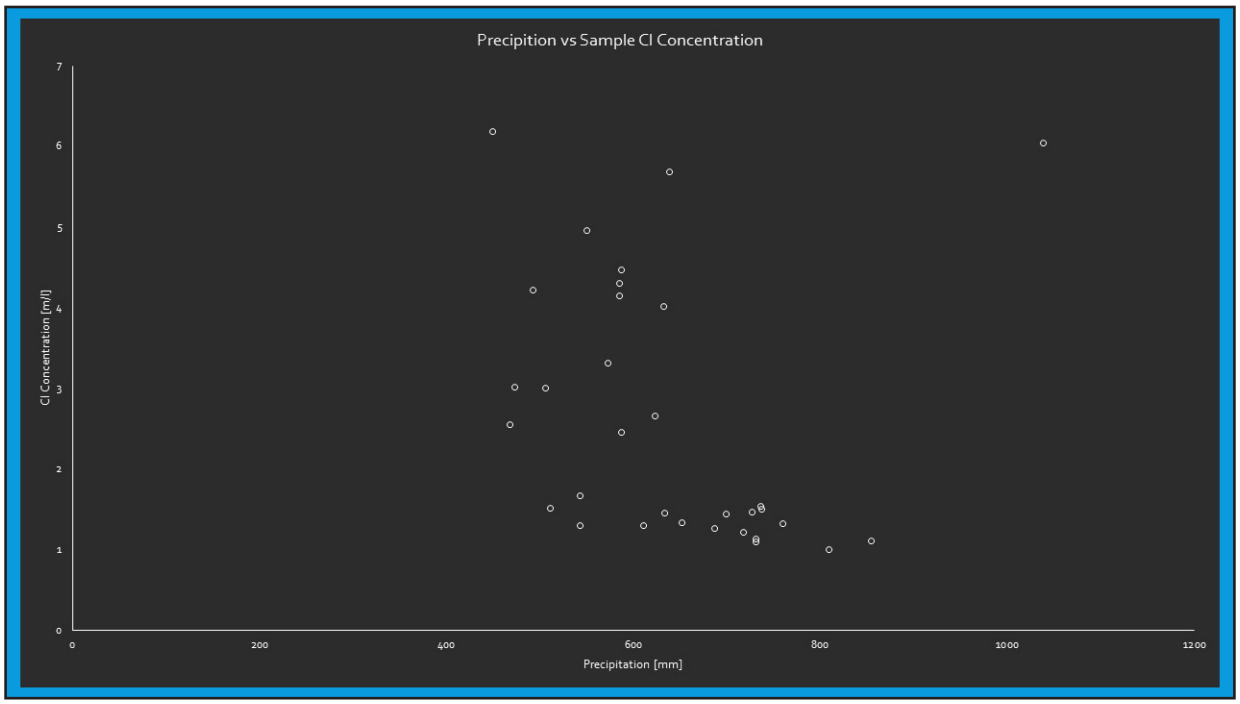

Figure 16. Precipitation v. sample chlorine concentration.

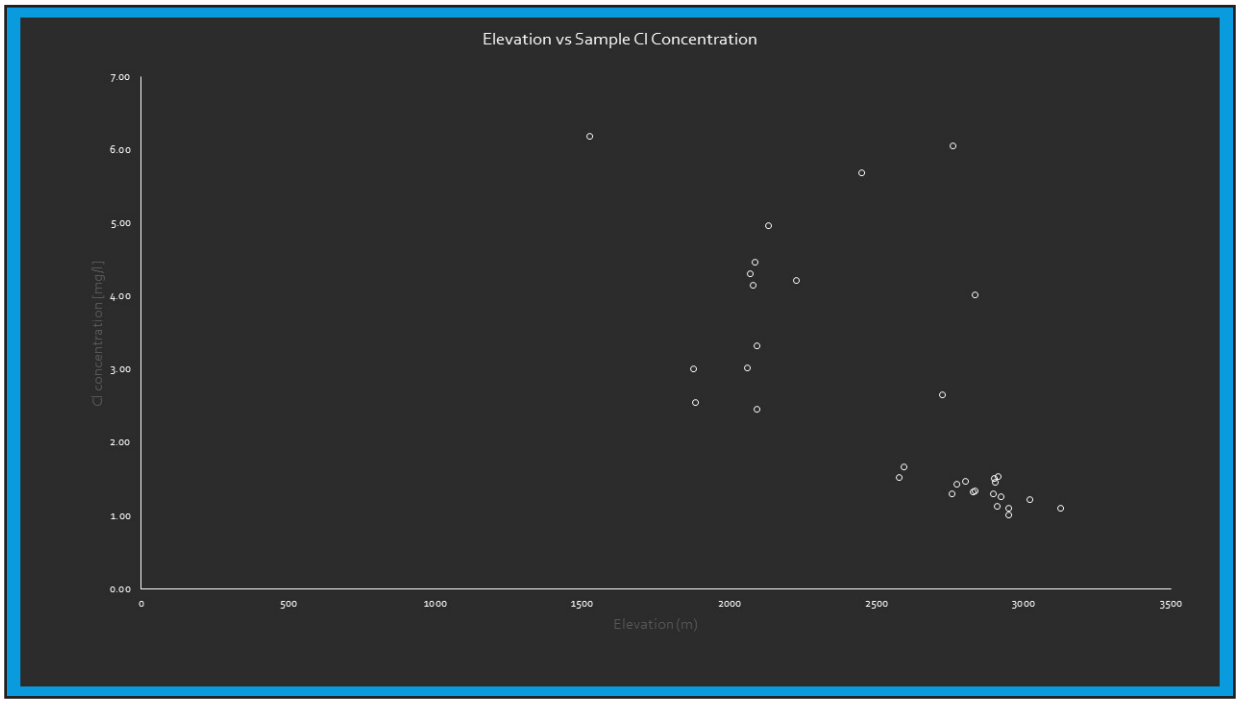

Figure 17. Elevation v. sample chloride concentration.

Site ID	Region	SC (µS/cm)	Lab pH	TDS	Water Type	Ca	Na	Ca:Na Ratio	Mg	K	HCO_3	SO_4	Cl	Br	Cl:Br Ratio	Sample Date
SR-0003A	Gualadule Mtns	676	8.4	397	$Mg-Ca-HCO_3$	65.6	4.10	16.0	55.4	0.790	431	37.0	5.46	0.1	52	3/15/2015
SR-0005A	Gualadule Mtns	587	8.2	326	$Mg-Ca-HCO_3$	60.9	3.28	18.6	39.9	0.731	375	19.8	3.27	0.034	97	3/16/2015
SR-0006A	Gualadule Mtns	664	8.1	374	$Mg-Ca-HCO_3$	51.6	3.34	15.4	57.9	0.485	431	31.1	4.35	0.03	131	3/16/2015
SR-0008A	San Mateo Mtns	130	7.9	120	$Ca-Na-Mg-HCO_3-SO_4$	14.2	10.2	1.4	1.89	1.27	51	14.8	4.21	0.02	234	3/28/2015
SR-0009A	San Mateo Mtns	85	7.8	77	$Ca-Na-Mg-HCO_3-SO_4$	7.61	6.81	1.1	1.47	0.939	34	10.9	2.18	0.03	70	4/4/2015
SR-0013A	Apache N.F.	243	8.5	169	$Ca-Mg-Na-HCO_3$	24.0	17.3	1.4	5.92	0.753	138	11.3	4.04	0.09	45	5/2/2015
SR-0014A	Apache N.F.	435	7.5	290	$Ca-Mg-Na-HCO_3$	63.3	18.3	3.5	10.8	0.864	281	6.99	2.90	0.11	26	5/2/2015
SR-0015A	Apache N.F.	404	7.2	313	$Na-Ca-HCO_3$	4.86	91.9	0.1	2.24	0.818	249	10.6	3.10	0.05	61	5/2/2015
SR-0018A	Gila N.F.	186	7.2	147	$Mg-Ca-Na-HCO_3-SO_4$	17.7	6.39	2.8	7.85	2.75	73	23.1	5.90	0.01	454	5/9/2015
SR-0020A	Gila N.F.	83	6.6	67	$Mg-Ca-Na-HCO_3-SO_4$	9.33	3.53	2.6	2.14	0.511	39	6.66	1.94	0.04	53	5/15/2015
SR-0021A	Magdalena Ridge	158	7.8	102	$Ca-Mg-HCO_3$	25.5	2.83	9.0	3.17	0.965	85	6.53	1.24	0.03	36	5/21/2015
SR-0022A	Magdalena Ridge	174	7.6	103	$Ca-Mg-HCO_3$	22.6	2.81	8.0	5.84	0.884	99	6.64	1.18	0.03	37	5/21/2015
SR-0023A	Magdalena Ridge	99	7.4	62	$Ca-HCO_3-SO_4$	13.9	2.14	6.5	1.02	1.10	46	5.44	1.32	0.01	120	5/21/2015
SR-0025A	Magdalena Ridge	228	7.2	137	$Ca-Mg-HCO_3$	36.7	4.11	8.9	4.52	0.827	133	7.56	1.64	0.04	42	5/21/2015
SR-0026A	Mogote Ridge	90	6.2	70	$Ca-HCO_3-SO_4$	11.8	2.57	4.6	1.47	0.923	41	6.86	1.33			5/22/2015
SR-0027A	Mogote Ridge	91	6.2	72	$Ca-HCO_3-SO_4$	11.4	2.28	5.0	2.06	1.19	39	8.47	1.30	0.07	20	5/22/2015
SR-0029A	San Pedro Ridge	262	7.0	181	$Ca-HCO_3$	54.1	2.02	26.8	1.23	1.58	160	4.20	1.0	0.01	107	6/1/2015
SR-0030A	San Pedro Ridge	336	7.0	198	$Ca-HCO_3$	55.0	4.27	12.9	7.25	2.19	208	5.63	1.47	0.02	98	6/1/2015
SR-0031A	Pecos Canyon	354	7.2	204	$Ca-HCO_3$	70.4	1.32	53.3	2.27	0.310	206	16.0	1.10	0.01	152	6/2/2015
SR-0032A	Pecos Canyon	345	8.0	200	$Ca-Mg-HCO_3$	68.0	1.26	54.0	2.20	0.305	203	15.6	1.13	0.02	54	6/2/2015
SR-0033A	Pecos Canyon	534	7.4	322	$Mg-Ca-Na-HCO_3$	107	4.62	23.2	5.22	0.571	312	31.7	4.11	0.06	74	6/2/2015

Figure 18. Sample data for 2015.