

Supplemental Information:

Deep submarine infiltration of altered geothermal groundwater on the south Chilean Margin

Authors: Vincent J. Clementi¹, Yair Rosenthal^{1,2}, Samantha C. Bova^{1,5}, Elizabeth K. Thomas³, James D. Wright², Richard A. Mortlock², Owen C. Cowling³, Linda V. Godfrey², Laurel B. Childress⁴, and Expedition 379T Scientists

Affiliations

¹Department of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ, USA
(*corresponding author; clementi@marine.rutgers.edu)

²Department of Earth and Planetary Sciences, Rutgers University, Piscataway, NJ, USA

³Department of Geology, University at Buffalo, Buffalo, NY, USA

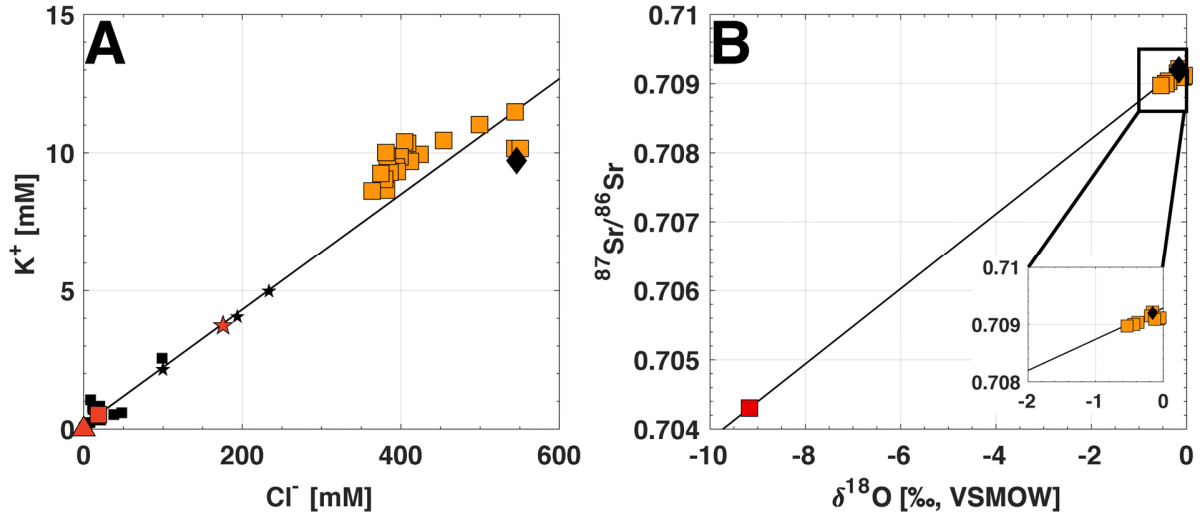
⁴International Ocean Discovery Program, Texas A&M University, College Station, TX, USA

⁵Present address: Department of Geological Sciences, San Diego State University, San Diego, CA, USA

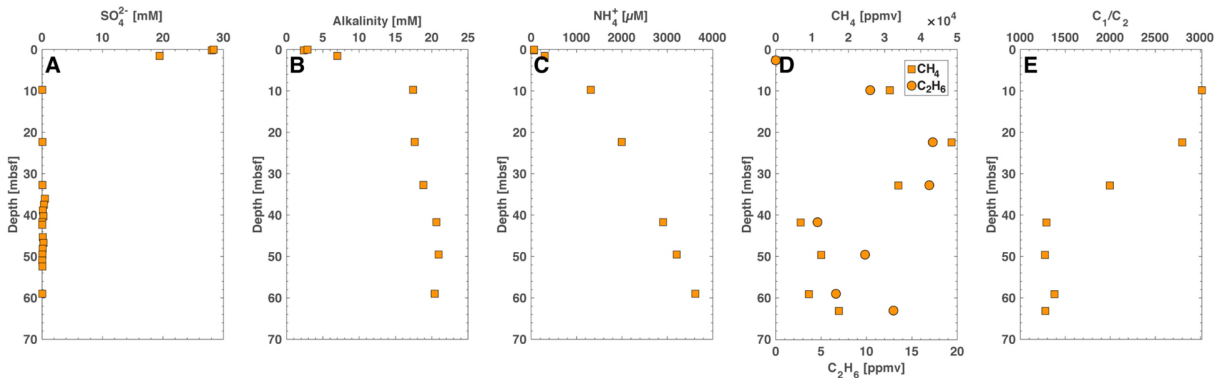
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1. Supplemental Figures

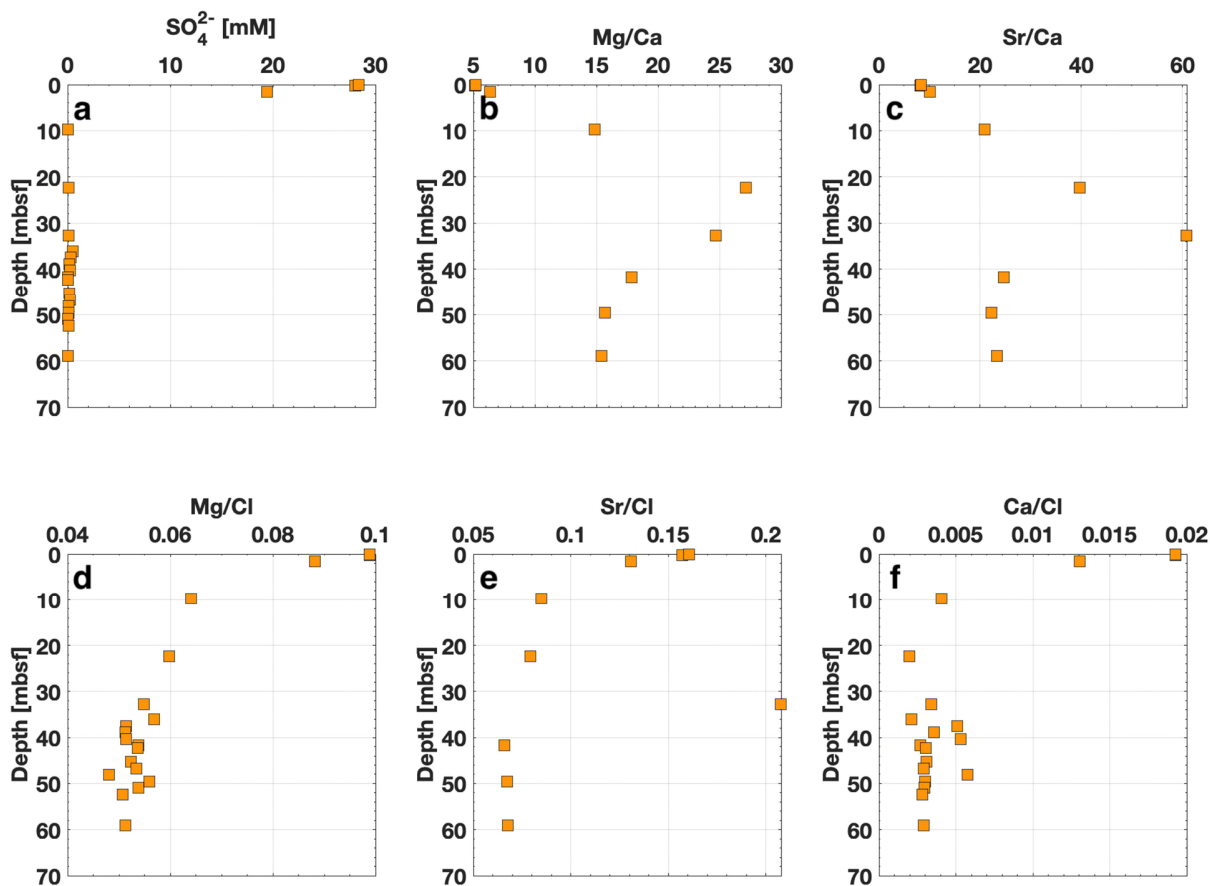


Supplemental Fig. 1. Additional mixing models. A) Cl^- against K^+ B) $\delta^{18}O$ against $^{87}Sr/^{86}Sr$. In A, data for thermal fluid (square), fjord water (star), and meteoric water (triangle) from the Aysén region reported by Negri et al. (ref. 1) are shown in black; averages for each subgroup are shown in red (see legend in Supplemental Fig. 1). In A, the mixing line is between geothermal groundwater and the first subsurface interstitial water sample (1.547 mbsf). For B, the mixing line is between geothermal groundwater and seawater. Seawater is denoted by the black diamond in both plots. The $^{87}Sr/^{86}Sr$ geothermal endmember is from Held et al. (ref. 2).

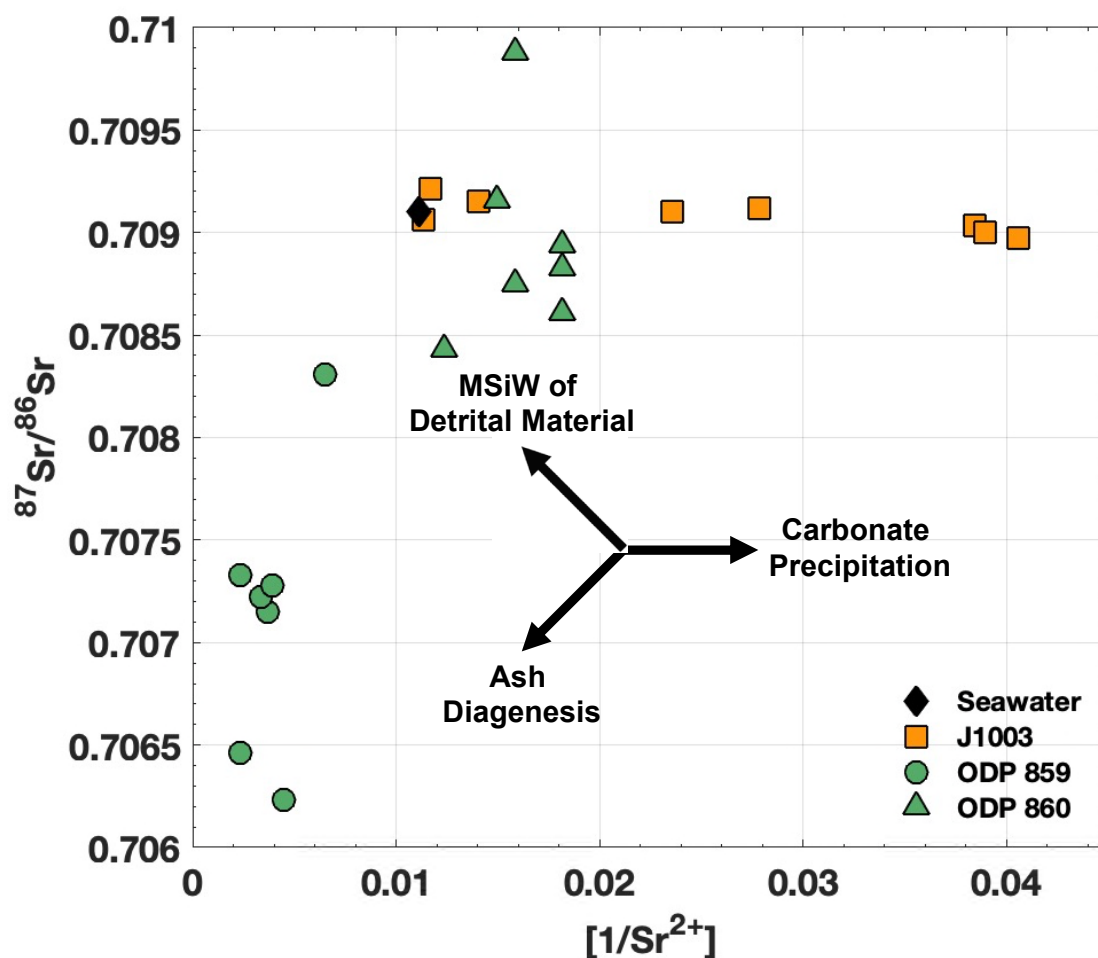


Supplemental Fig. 2. J1003 pore water profiles for A) sulfate (SO_4^{2-}), B) alkalinity, and C) ammonium (NH_4^+), D) headspace methane (CH_4 , square) and ethane (C_2H_6 , circle) concentrations, E) C_1/C_2 ratio.

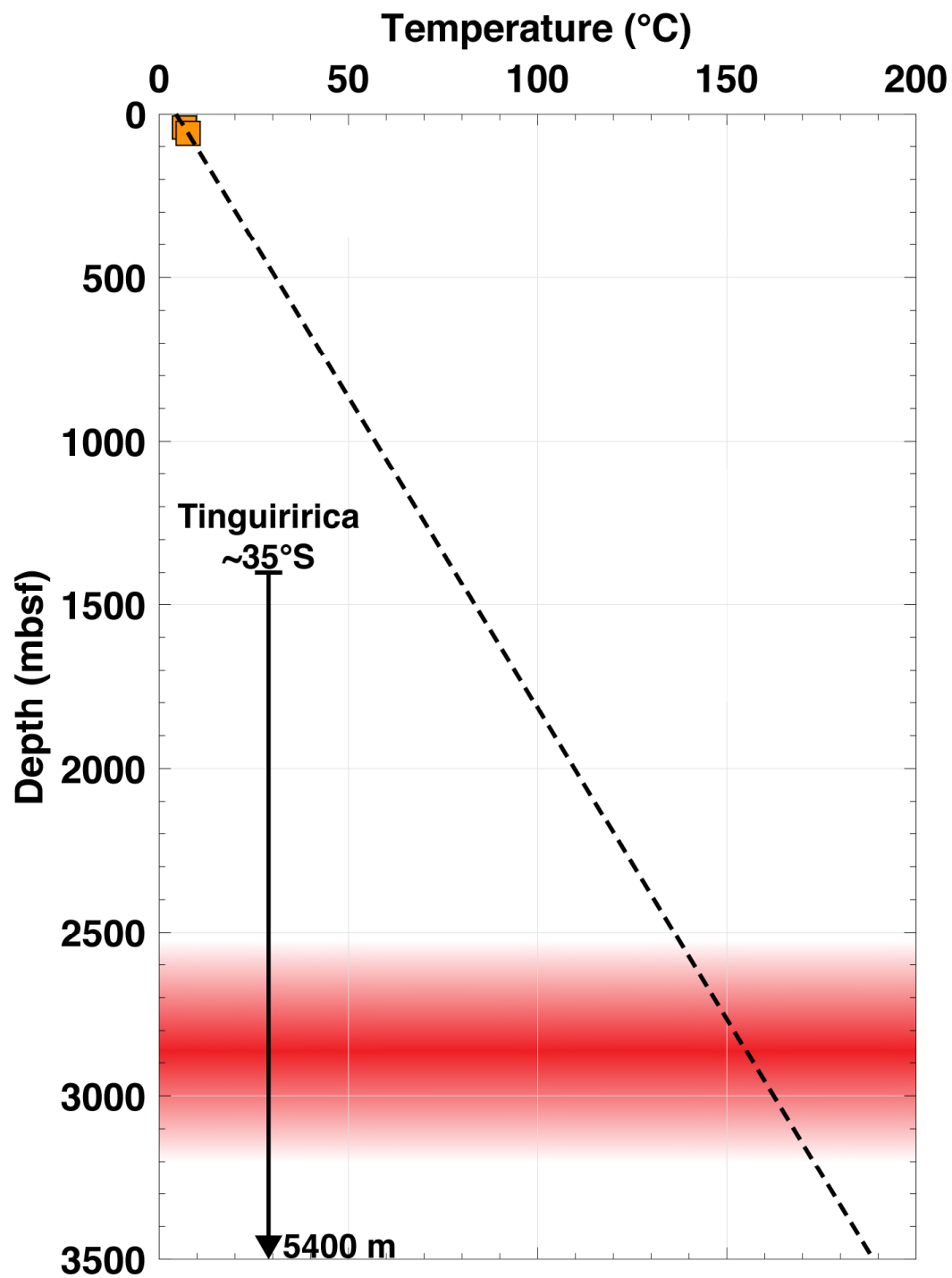
and E) downcore C_1/C_2 ratios. Depth is plotted on the vertical axis in meters below sea floor (mbsf). The source data for this figure are provided in the supplementary material.



Supplemental Fig. 3. Evidence for dolomitization. A) Pore water SO₄²⁻. Pore water ratios for B) Mg²⁺/Ca²⁺, C) Sr²⁺/Ca²⁺, D) Mg²⁺/Cl⁻, E) Sr²⁺/Cl⁻, and F) Ca²⁺/Cl⁻. The dolomite-rich interval at J1003 occupies the sediment column between 15-40 mbsf³, where maximum values in Mg²⁺/Ca²⁺ and Sr²⁺/Ca²⁺ are documented. Depth is plotted on the vertical axis in meters below sea floor (mbsf).

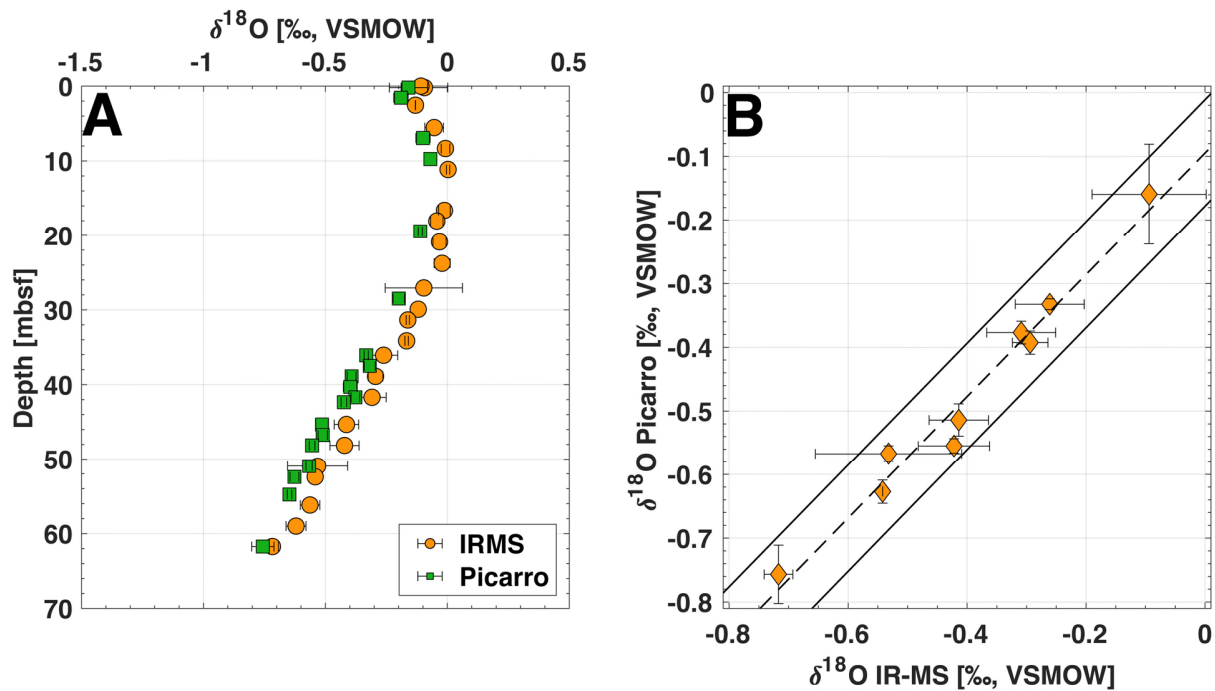


Supplemental Fig. 4. Strontium systematics. Pore water $^{87}\text{Sr}/^{86}\text{Sr}$ plotted against the inverse Sr^{2+} concentration for Site J1003 (orange) and ODP Sites 859 (green circle) and 860 (green triangle)⁴. The seawater reference value is denoted by the black diamond. The schematic inset indicates the general direction of change associated with marine silicate weathering (MSiW) of detrital material, authigenic carbonate precipitation, and ash diagenesis. The marked consumption of Sr^{2+} without any substantial change in Sr isotope provides strong evidence that Sr^{2+} concentrations are largely controlled by authigenic carbonate precipitation, likely dolomite as evidenced by $\text{Mg}^{2+}/\text{Ca}^{2+}$ and $\text{Sr}^{2+}/\text{Ca}^{2+}$ ratios.



Supplemental Fig. 5. Depth estimates for the Aysén geothermal groundwater reservoir. J1003 temperature measurements from the advanced piston corer temperature tool (APCT-3) are shown in orange. The geothermal gradient for J1003 ($53\text{ }^{\circ}\text{C km}^{-1}$) is indicated by the dotted black line. The range of Aysén geothermal groundwater temperature estimates is shown in red; the darker hue indicates average, whereas the lighter hue marks the bounds of the 95% C.I. Depth estimates

from the nearby Tinguiririca geothermal reservoir (35°S) are marked by the black arrow^{5,6}. Depth is plotted on the vertical axis in meters below sea floor (mbsf).



Supplemental Fig. 6. Comparing pore water $\delta^{18}\text{O}$ determination between Picarro and IR-MS methodology. A) Downcore records for IR-MS (orange) and Picarro (green) generated data. Error bars for Picarro measurements represent 1 standard deviation (1 SD) for each sample's analysis. Error bars for IR-MS measurements represent the difference between duplicate analyses for each sample. Depth is plotted on the vertical axis in meters below sea floor (mbsf). B) Cross plot comparing data from the two instruments. The dotted black line is a linear fit of the data ($r^2 = 0.97$, $n=9$) with solid lines representing upper and lower bounds of the 95% confidence interval. Data fall close to the 1:1 line, with a near constant offset ($0.077 \pm 0.02\text{‰}$) towards lower values determined using the Picarro.

2. Supplemental Table 1

Na⁺/K⁺ estimates of the Aysén geothermal groundwater reservoir temperature (GRT).				
	GRT (°C) ^a	GRT (°C) ^b	GRT (°C) ^c	GRT (°C) ^d
This Study	173.68±2.06	154.80±2.16	139.34±2.75	142.99±2.11
Negri et al. ²	175±14.3	156±15.1	142±19.7	144.17±14.8
^a Giggenbach [ref. 7]: $T^{\circ}\text{C} = 1390/(\log \text{Na/K} + 1.750) - 273.15$ ^b Fournier [ref. 8]: $T^{\circ}\text{C} = 1217/(\log \text{Na/K} + 1.483) - 273.15$ ^c Tonani [ref. 9]: $T^{\circ}\text{C} = 883/(\log \text{Na/K} + 0.780) - 273.15$ ^d Nieva & Nieva [ref. 10]: $T^{\circ}\text{C} = 1178/(\log \text{Na/K} + 1.470) - 273.15$ <i>Notes: Concentration of Na and K in mg/L. Reported error is the 95% C.I.</i>				

3. Supplemental References

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