**Supporting Information**

**Recovery of rare earth elements from geothermal fluids through bacterial cell surface adsorption**

For submission to *Environmental Science and Technology*

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**Table S1:** Metal concentration profile of the initial Blue Mountain geothermal fluid (BMG) prior to biosorption and of the recovered eluent upon desorption with 5 mM citrate. Data below the detection limit are reported as ‘bd’. The extraction efficiency is defined as the percent of a given metal recovered by one cycle of biosorption and elution.

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| --- | --- | --- | --- |
| **Metal** | **Feedstock Concentration (ppb)** | **Eluent Concentration (ppb)** | **Extraction Efficiency (%)** |
| Li | 1733 | 12 | 0.71 |
| Na | 838,392 | 6311 | 0.75 |
| Mg | 1448 | 76 | 5.25 |
| K | 87,874 | bd | 0.00 |
| Ca | 23,251 | bd | 0.00 |
| Mn | 99 | 9 | 8.81 |
| Fe | 737 | 216 | 29.30 |
| As | 20 | bd | 0.00 |
| Rb | 426 | 3 | 0.69 |
| Sr | 1068 | 21 | 1.93 |
| Cs | 155 | bd | 0.00 |
| Ba | 162 | bd | 0.00 |
| W | 31 | bd | 0.00 |
| Tb | 9.40 | 7.16 | 76.21 |

**Table S2:** Tb, Na, and Mg extracted from GSL of different TDS. \*Note that the Na concentration of the sodium citrate used for elution is ~369 ppm, and thus the Na present is not derived from GSL but from the citrate desorbent.

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| --- | --- | --- | --- |
| **TDS (ppm)** | **Tb (ppb)** | **Na (ppm)\*** | **Mg (ppm)** |
| 165,000 | 63.0 ± 3.7 | 341.6 ± 3.2 | 2.2 ± 0.3 |
| 55,100 | 64.9 ± 3.9 | 339.1 ± 2.5 | 1.9 ± 0.2 |
| 16,500 | 66.1 ± 1.6 | 343.4 ± 6.2 | 1.3 ± 0.0 |
| 1,650 | 56.1 ± 6.2 | 343.1 ± 2.3 | 0.8 ± 0.1 |
| 165 | 56.3 ± 7.8 | 358.7 ± 1.2 | 1.6 ± 0.9 |
| 5.4 | 52.0 ± 3.1 | 370.0 ± 9.2 | 0.3 ± 0.1 |

**Table S3:** Tb adsorption by the LBT-displayed *E. coli* in MES buffer (pH 6) over time. The initial Tb concentration was ~8 ppm (50 μM) and the cell concentration was ~1.2x109 cells/ml.

|  |  |
| --- | --- |
| **Time (min)** | **Tb Adsorbed (μM)** |
| 5 | 41.36 ± 0.43 |
| 10 | 41.27 ± 0.78 |
| 20 | 42.20 ± 0.39 |
| 40 | 41.72 ± 0.83 |
| 90 | 41.60 ± 0.66 |



**Figure S1:** Linear free energy relationship dependence on temperature for Zn, Cd, and Pb. *Penicillium simplicissimum* was used to experimentally generate the metal-bacteria logKs for Zn, Cd, and Pb (open symbols).34 La-acetate,35 Na-acetate,36 Cu-acetate,33 and UO2-acetate37 stability constants were used in the computed linear free energy equations to obtain fitted La-, Na-, Cu- and U(VI)-bacteria Langmuir affinity logKs (closed symbols, asterisked metal names). Most notably, this figure illustrates that the linear free energy relationships become steeper in slope as temperature increases.

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**Figure S2:** Propidium iodide staining of LBT-displayed *E. coli* that were heated to 70°C for 30 min and cooled back to room temperature before imaging. Composite of phase contrast and fluorescence images (490/635 nm) of dead cells stained with propidium iodide during a bacterial viability test (*Bac*LightTM, ThermoFisher).

**Figure S3:**Tb recovery from the synthetic GSL brine. Initial Tb concentration was ~48 ppm (300 μM) and cell concentration were maintained at ~1.2x109 cells/ml. Note that temperature above 70°C (i.e., 100°C) did not improve recovery efficiency.