# A Hydrolytically Stable Complexant for Minor An Separation from Ln in Process Relevant Diluents

*Supporting Information*

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## Experimental Section

**Chemicals.** All reagents were purchased from U.S. chemical suppliers, stored according to published protocols, and used as received unless indicated otherwise. All aqueous solutions were prepared with Milli-Q type 1 water system.

**Small-Scale Dissolution.** A small amount of mass, generally between 10 and 20 mg, was accurately weighed out into a sample tube. Ten microliters of the appropriate diluent (Exxal-8 or kerosene) were added to the sample vial and sonicated for five to thirty minutes. This step was repeated until complete dissolution of the complexant was observed. The sample was capped, parafilmed, and left for 24 hours to ensure the complexant did not crash out of solution.

**Solvent Extraction.** Organic phase. An appropriate mass of **1** was transferred from a sample vial to a 5.0 mL Class A volumetric flask to make a concentrated stock solution. Weighing by difference was used on the original sample vial to calculate the actual mass of **1** dissolved. The solvent was added to the flask and manually agitated to facilitate dissolution. Generally, the complexant was fully dissolved after 5 minutes of sonication. Various concentrations of **1** were prepared from the concentrated stock solution in 1.0 or 2.0 mL Class A volumetric glassware. **Aqueous phase.** Eight concentrated stock solutions of $^{241}Am^{3+}$ were prepared in various concentrations of $HNO_3$ (0.25−5.0 M). These $^{241}Am^{3+}$ stock solutions were used throughout the entirety of this study to spike the working aqueous phase of the matching [$HNO_3$]. Initial counts of the aqueous phase were generally 3400-4000 cpm / 200 µL. This method was repeated for $^{154}Eu^{3+}$. **Extraction.** Equal volumes (0.6 mL) of the organic and active aqueous phase, in that order, were added to a 1.5 mL microcentrifuge tube. The centrifuge tubes were capped and wrapped in parafilm then placed on a pulsing vortex shaker at 1700 rpm for the appropriate time. After the allotted time on the vortex shaker, the samples were centrifuged for five minutes to achieve phase separation. The organic and aqueous phases were transferred to separate 1.5 mL centrifuge tubes with a disposable fine-tip transfer pipette. A 200 µL aliquot of each phase was transferred to a counting tube with sampling performed in duplicate. **Gamma Spectroscopy.** A 2480 Wizard$^2$ automatic gamma counter with 3 inch NaI(Tl) was used for the determination of $^{241}Am^{3+}$ and $^{154}Eu^{3+}$ activity of samples. Samples were counted for 10 minutes, or until total counts reached 10000, and the instrument software relayed the results as counts per minute (CPM). The distribution ratios of a given metal ion ($D_M$) were calculated according to Equation 1 where [M] is the net CPM of either the organic phase (numerator) or aqueous phase (denominator). Separation factors (SF) were calculated using Equation 2. Values are reported in figures as an average of duplicate samples with error bars representing uncertainties calculated at 2σ from the counting error. The supporting information for this work provides additional detail.

$$D_M = \frac{[M]org}{[M]aq} \qquad \textit{Equation (1)}$$

$$SF_{Am(III)/Eu(III)} = \frac{D_{Am(III)}}{D_{Eu(III)}} \qquad \textit{Equation (2)}$$

**UV-vis Titration.** UV-visible spectrophotometric titrations were performed in a 3 mL, 1.00 cm path length quartz cuvette, using a Cary 5000 UV-vis spectrophotometer. For each titration, an appropriate volume of a $1.5\times10^{-3}$ M $Ln(NO_3)_3$ (Ln = Nd, Eu) solution in 99% acetonitrile/1% water (v/v) was added to 2.0 mL of a $1.5\times10^{-5}$ M solution of **1** in the same solvent system. The total volume of $Ln(NO_3)_3$ added was 60 µL. A wavelength scan from 225 to 450 nm at a scan rate of 100 nm per minute and a 5 data point average was taken of the free (uncomplexed) complexant and after each titration. The sample was manually agitated for three minutes after each titration to ensure complete complexation. The titration was complete when the variation in absorbance became negligible. Raw spectra were baseline corrected with OriginPro software and imported into HypSpec software for determination of stability constants by nonlinear regression curve fitting.

***Counting Statistics***

A critical limit ($L_C$, *Equation S1*) was calculated for every counting (solvent extraction) experiment (**Tables S1, S2, S4, S5, S7,** and **S8**) to determine if the net count was statistically significant at the 95% confidence level.

$$L_C = 1.645\sqrt{2B} \qquad \textit{Equation S1}$$

When a net CPM was found to be below the calculated $L_C$ a footnote was added to the data table (**Tables S5** and **S8**) to indicate that the activity is not detected and an upper limit ($L_U$, *Equation S2*) at the 95% confidence is reported. The calculated values were left in the raw data tables with a footnote, but these values were not used to report a distribution value in the associated summary table (**Tables S6** and **S9**) or figure (**Figure 2**).

$$L_U = cpm_{net} + 1.645\sqrt{(cpm_{net} + 2B)} \qquad \textit{Equation S2}$$

The uncertainty for each distribution value ($D_M$, where M = $^{241}Am^{3+}$ or $^{154}Eu^{3+}$) was calculated from the counting error (2σ) according to *Equation S3*:

$$\sigma_{D_M} = D_M \times \sqrt{\left(\frac{\left(\sqrt{\sigma_{org}{}^2 + \sigma_{blank}{}^2}\right)}{Net\ cpm_{org}}\right)^2 + \left(\frac{\left(\sqrt{\sigma_{aq}{}^2 + \sigma_{blank}{}^2}\right)}{Net\ cpm_{aq}}\right)^2} \qquad \textit{Equation S3}$$

The uncertainty for the average $D_M$ was calculated according to *Equation S4* and reported in the summary tables (**Tables S3**, **S6**, and **S9**).

$$\sigma_{Avg(D_M)} = \frac{\sqrt{\sigma D_1{}^2 + \sigma D_2{}^2}}{2} \qquad \textit{Equation S4}$$

$D_1$ and $D_2$ refer to the individual $D_M$ values from duplicate samples taken for each data point.

**Table S1. Raw Data to Accompany Figure 1(a).** $^{241}Am^{3+}$ **Distribution (*D*)-values, at 1M** $HNO_{3(aq)}$ **as *f*(t) in Kerosene/Exxal (50v/50v)**

| Time (min.) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Am}$ (org./aq.) | $D_{Am}$ Avg. |
|---|---|---|---|---|---|---|---|
| **5** | org. - 1 | 502 | 1.28 | 481 | 101.0 | 0.1553 | 0.1542 |
| | org. - 2 | 491 | 1.26 | 470 | 99.8 | 0.1532 | |
| | aq. - 3 | 3119 | 1.00 | 3098 | | | |
| | aq. - 4 | 3089 | 1.00 | 3068 | | | |
| **10** | org. - 5 | 863 | 1.00 | 842 | 100.6 | 0.3089 | 0.3309 |
| | org. - 6 | 933 | 1.00 | 912 | 98.6 | 0.3529 | |
| | aq. - 7 | 2747 | 1.00 | 2726 | | | |
| | aq. - 8 | 2605 | 1.00 | 2584 | | | |
| **20** | org. - 9 | 1509 | 1.00 | 1488 | 98.1 | 0.7485 | 0.7627 |
| | org.- 10 | 1560 | 1.00 | 1539 | 99.3 | 0.7769 | |
| | aq. - 11 | 2009 | 1.00 | 1988 | | | |
| | aq. - 12 | 2002 | 1.00 | 1981 | | | |
| **30** | org. -13 | 1813 | 1.00 | 1792 | 96.0 | 1.112 | 1.134 |
| | org. -14 | 1911 | 1.00 | 1890 | 99.4 | 1.156 | |
| | aq. - 15 | 1633 | 1.00 | 1612 | | | |
| | aq. - 16 | 1656 | 1.00 | 1635 | | | |
| **45** | org. -17 | 2128 | 1.00 | 2107 | 97.5 | 1.563 | 1.590 |
| | org. -18 | 2206 | 1.00 | 2185 | 99.8 | 1.616 | |
| | aq. - 19 | 1369 | 1.00 | 1348 | | | |
| | aq. - 20 | 1373 | 1.00 | 1352 | | | |
| **60** | org. -21 | 2337 | 1.00 | 2316 | 98.1 | 1.995 | 2.024 |
| | org.-22 | 2403 | 1.00 | 2382 | 99.9 | 2.053 | |
| | aq. - 23 | 1182 | 1.00 | 1161 | | | |
| | aq. - 24 | 1181 | 1.00 | 1160 | | | |
| **90** | org. -25 | 2341 | 1.00 | 2320 | 97.5 | 2.042 | 2.030 |
| | org. -26 | 2357 | 1.00 | 2336 | 98.6 | 2.017 | |
| | aq. - 27 | 1157 | 1.00 | 1136 | | | |
| | aq. - 28 | 1179 | 1.00 | 1158 | | | |
| **120** | org. -29 | 2345 | 1.00 | 2324 | 97.0 | 2.084 | 2.104 |
| | org. -30 | 2470 | 1.00 | 2449 | 101.6 | 2.124 | |
| | aq. - 31 | 1136 | 1.00 | 1115 | | | |
| | aq. - 32 | 1174 | 1.00 | 1153 | | | |
| $A_0$ | $A_0$ - 33 | 3565 | 1.00 | 3544 | | | |
| $A_0$ | $A_0$ - 34 | 3567 | 1.00 | 3546 | | | |
| $A_0$ | Avg. | 3566 | 1.00 | 3545 | | | |
| Blank | Avg. | 21 | 6.87 | | | | |

**Table S2. Raw Data to Accompany Figure 1(a).** $^{152}Eu^{3+}$ **Distribution (*D*)-values, at 1M** $HNO_{3(aq)}$ **as *f*(t) in Kerosene/Exxal (50v/50v)**

| Time (min.) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Eu}$ (org./aq.) | $D_{Eu}$ (Avg.) |
|---|---|---|---|---|---|---|---|
| **5** | org. - 1 | 197 | 2.22 | 46 | 101.7 | 0.0125 | 0.0128 |
| | org. - 2 | 199 | 2.22 | 48 | 100.5 | 0.0132 | |
| | aq. - 3 | 3838 | 1.00 | 3687 | | | |
| | aq. - 4 | 3794 | 1.00 | 3643 | | | |
| **10** | org. - 5 | 199 | 2.29 | 48 | 99.2 | 0.0134 | 0.0127 |
| | org. - 6 | 195 | 2.22 | 44 | 100.4 | 0.0121 | |
| | aq. - 7 | 3746 | 0.99 | 3595 | | | |
| | aq. - 8 | 3794 | 1.00 | 3643 | | | |
| **20** | org. - 9 | 200 | 2.26 | 49 | 100.6 | 0.0134 | 0.0126 |
| | org. -10 | 194 | 2.24 | 43 | 100.5 | 0.0118 | |
| | aq. - 11 | 3795 | 1.00 | 3644 | | | |
| | aq. - 12 | 3799 | 1.00 | 3648 | | | |
| **30** | org. -13 | 195 | 2.26 | 44 | 100.6 | 0.0121 | 0.0131 |
| | org. -14 | 202 | 2.28 | 51 | 99.5 | 0.0142 | |
| | aq. - 15 | 3801 | 1.00 | 3650 | | | |
| | aq. - 16 | 3752 | 1.00 | 3601 | | | |
| **45** | org. -17 | 207 | 2.25 | 56 | 98.4 | 0.0157 | 0.0136 |
| | org. -18 | 193 | 2.28 | 42 | 100.4 | 0.0115 | |
| | aq. - 19 | 3707 | 1.00 | 3556 | | | |
| | aq. - 20 | 3796 | 1.00 | 3645 | | | |
| **60** | org. -21 | 200 | 2.26 | 49 | 98.8 | 0.0137 | 0.0138 |
| | org-22 | 201 | 2.27 | 50 | 99.0 | 0.0139 | |
| | aq. - 23 | 3730 | 1.00 | 3579 | | | |
| | aq. - 24 | 3738 | 1.00 | 3587 | | | |
| **90** | org. -25 | 193 | 2.26 | 42 | 98.3 | 0.0118 | 0.0125 |
| | org. -26 | 200 | 2.28 | 49 | 102.6 | 0.0132 | |
| | aq. - 27 | 3720 | 1.00 | 3569 | | | |
| | aq. - 28 | 3869 | 1.00 | 3718 | | | |
| **120** | org. -25 | 202 | 2.25 | 51 | 98.7 | 0.0143 | 0.0141 |
| | org. -26 | 202 | 2.34 | 51 | 100.5 | 0.0140 | |
| | aq. - 27 | 3723 | 1.00 | 3572 | | | |
| | aq. - 28 | 3792 | 1.00 | 3641 | | | |
| $A_0$ | $A_0$ - 33 | 3876 | 1.00 | 3725 | | | |
| $A_0$ | $A_0$ - 34 | 3770 | 1.00 | 3619 | | | |
| $A_0$ | Avg. | 3823 | 1.00 | 3672 | | | |
| Blank | Avg. | 151 | 2.61 | | | | |

**<u>Table S3</u>. Summary $D_M$ for Tables S1 and S2**

| **Time (min)** | ***$D_{Am}$* Avg.** | ***$D_{Am}$* Uncertainty (2σ)** | ***$D_{Eu}$* Avg.** | ***$D_{Eu}$* Uncertainty (2σ)** | ***SF* (Avg.) ($D_{Am}$ / $D_{Eu}$)** | ***SF* Uncertainty (2σ)** |
|---|---|---|---|---|---|---|
| **5** | 0.1542 | 0.004 | 0.0128 | 0.002 | 12.0 | 2.2 |
| **10** | 0.3309 | 0.007 | 0.0127 | 0.002 | 26.0 | 4.8 |
| **20** | 0.7627 | 0.015 | 0.0126 | 0.002 | 60.4 | 11.1 |
| **30** | 1.134 | 0.023 | 0.0131 | 0.002 | 86.5 | 15.6 |
| **45** | 1.590 | 0.032 | 0.0136 | 0.002 | 117 | 20.4 |
| **60** | 2.024 | 0.041 | 0.0138 | 0.002 | 147 | 25.4 |
| **90** | 2.030 | 0.041 | 0.0125 | 0.002 | 163 | 30.4 |
| **120** | 2.104 | 0.043 | 0.0141 | 0.002 | 149 | 25.4 |

**<u>Table S4</u>. Raw Data to Accompany Figure 2(b). $^{241}Am^{3+}$ Distribution (*D*)-values, *f*($HNO_{3(aq)}$) with Initial Concentration in Kerosene/Exxal (50v/50v) of 25 mM**

| $[HNO_3]$ (M) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Am}$ (org./aq.) | $D_{Am}$ Avg. |
|---|---|---|---|---|---|---|---|
| **0.25** | org. - 1 | 1175 | 1.00 | 1153 | 100.7 | 0.4358 | 0.4503 |
| | org. - 2 | 1217 | 1.00 | 1195 | 99.9 | 0.4648 | |
| | aq. - 3 | 2668 | 1.00 | 2646 | | | |
| | aq. - 4 | 2593 | 1.00 | 2571 | | | |
| **0.5** | org. - 5 | 1687 | 1.00 | 1665 | 97.7 | 0.9224 | 0.9431 |
| | org. - 6 | 1775 | 1.00 | 1753 | 100.6 | 0.9637 | |
| | aq. - 7 | 1827 | 1.00 | 1805 | | | |
| | aq. - 8 | 1841 | 1.00 | 1819 | | | |
| **0.75** | org. - 9 | 2399 | 1.00 | 2377 | 101.2 | 1.799 | 1.850 |
| | org. -10 | 2509 | 1.00 | 2487 | 103.9 | 1.901 | |
| | aq. - 11 | 1343 | 1.00 | 1321 | | | |
| | aq. - 12 | 1330 | 1.00 | 1308 | | | |
| **1.0** | org. -13 | 2877 | 1.00 | 2855 | 98.3 | 2.648 | 2.695 |
| | org. -14 | 3037 | 1.00 | 3015 | 102.8 | 2.741 | |
| | aq. - 15 | 1100 | 1.00 | 1078 | | | |
| | aq. - 16 | 1122 | 1.00 | 1100 | | | |
| **2.0** | org. -17 | 3118 | 1.00 | 3096 | 97.2 | 10.12 | 10.25 |
| | org. -18 | 3220 | 1.00 | 3198 | 100.1 | 10.38 | |
| | aq. - 19 | 328 | 1.75 | 306 | | | |
| | aq. - 20 | 330 | 1.74 | 308 | | | |
| **3.0** | org. -21 | 3474 | 1.00 | 3452 | 96.4 | 13.18 | 13.45 |
| | org.-22 | 3673 | 1.00 | 3651 | 101.6 | 13.73 | |
| | aq. - 23 | 284 | 1.88 | 262 | | | |
| | aq. - 24 | 288 | 1.86 | 266 | | | |
| **4.0** | org. -25 | 2954 | 1.00 | 2932 | 95.0 | 8.778 | 9.006 |
| | org. -26 | 3152 | 1.00 | 3130 | 100.9 | 9.233 | |
| | aq. - 27 | 356 | 1.68 | 334 | | | |
| | aq. - 28 | 361 | 1.66 | 339 | | | |
| **5.0** | org. -25 | 3055 | 1.00 | 3033 | 97.9 | 9.721 | 9.699 |
| | org. -26 | 3109 | 1.00 | 3087 | 99.7 | 9.677 | |
| | aq. - 27 | 334 | 1.73 | 312 | | | |
| | aq. - 28 | 341 | 1.71 | 319 | | | |
| **0.25** | $A_0$ – 33 | 3793 | 1.00 | 3771 | | | |
| **0.50** | $A_0$ – 34 | 3572 | 1.00 | 3550 | | | |
| **0.75** | $A_0$ – 35 | 3674 | 1.00 | 3652 | | | |
| **1.0** | $A_0$ – 36 | 4024 | 1.00 | 4002 | | | |
| **2.0** | $A_0$ – 37 | 3523 | 1.00 | 3501 | | | |
| **3.0** | $A_0$ – 38 | 3875 | 1.00 | 3853 | | | |
| **4.0** | $A_0$ – 39 | 3460 | 1.00 | 3438 | | | |

| | | | | |
|---|---|---|---|---|
| **5.0** | $A_0 - 40$ | 3438 | 1.00 | 3416 |
| Blank | Avg. | 22 | 6.88 | |

**Table S5. Raw Data to Accompany Figure 2(b). $^{154}Eu^{3+}$ Distribution (*D*)-values, *f*($HNO_{3(aq)}$) with Initial Concentration in Kerosene/Exxal (50v/50v) of 25 mM**

| $[HNO_3]$ (M) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Eu}$ (org./aq.) | $D_{Eu}$ Avg. |
|---|---|---|---|---|---|---|---|
| **0.25** | org. - 1 | 179 | 2.36 | 31 | 103.1 | 0.0077 | 0.0076 |
| | org. - 2 | 178 | 2.37 | 30 | 102.3 | 0.0075 | |
| | aq. - 3 | 4208 | 1.00 | 4060 | | | |
| | aq. - 4 | 4178 | 1.00 | 4030 | | | |
| **0.5** | org. - 5 | 194 | 2.27 | 46 | 102.4 | 0.0122 | 0.0139 |
| | org. - 6 | 208 | 2.19 | 60 | 104.0 | 0.0156 | |
| | aq. - 7 | 3955 | 1.00 | 3807 | | | |
| | aq. - 8 | 4001 | 1.00 | 3853 | | | |
| **0.75** | org. - 9 | 277 | 1.90 | 129 | 101.1 | 0.0253 | 0.0253 |
| | org. -10 | 276 | 1.90 | 128 | 100.4 | 0.0253 | |
| | aq. - 11 | 5251 | 1.00 | 5103 | | | |
| | aq. - 12 | 5213 | 0.99 | 5065 | | | |
| **1.0** | org.- 13 | 332 | 1.74 | 184 | 100.5 | 0.0319 | 0.0326 |
| | org.- 14 | 341 | 1.71 | 193 | 100.8 | 0.0334 | |
| | aq. - 15 | 5927 | 0.99 | 5779 | | | |
| | aq. - 16 | 5938 | 0.99 | 5790 | | | |
| **2.0** | org. -17 | 351 | 1.69 | 203 | 100.7 | 0.0645 | 0.0660 |
| | org. -18 | 363 | 1.66 | 215 | 102.2 | 0.0675 | |
| | aq. - 19 | 3298 | 1.00 | 3150 | | | |
| | aq. - 20 | 3335 | 1.00 | 3187 | | | |
| **3.0** | org. -21 | 458 | 1.48 | 310 | 101.2 | 0.0848 | 0.0885 |
| | org.-22 | 482 | 1.44 | 334 | 100.8 | 0.0923 | |
| | aq. - 23 | 3808 | 1.00 | 3660 | | | |
| | aq. - 24 | 3770 | 1.00 | 3622 | | | |
| **4.0** | org. -25 | 381 | 1.62 | 233 | 105.9 | 0.0624 | 0.0618 |
| | org.- 26 | 371 | 1.64 | 223 | 103.1 | 0.0613 | |
| | aq. - 27 | 3889 | 1.00 | 3741 | | | |
| | aq. - 28 | 3793 | 1.00 | 3645 | | | |
| **5.0** | org.- 29 | 413 | 1.56 | 265 | 102.0 | 0.0720 | 0.0724 |
| | org.- 30 | 418 | 1.55 | 270 | 103.0 | 0.0727 | |
| | aq. - 31 | 3832 | 1.00 | 3684 | | | |
| | aq. - 32 | 3863 | 1.00 | 3715 | | | |
| **0.25** | $A_0$ – 33 | 4118 | 1.00 | 3970 | | | |
| **0.50** | $A_0$ – 34 | 3911 | 1.00 | 3763 | | | |
| **0.75** | $A_0$ – 35 | 5321 | 1.00 | 5173 | | | |
| **1.0** | $A_0$ – 36 | 6083 | 1.00 | 5935 | | | |
| **2.0** | $A_0$ – 37 | 3477 | 1.00 | 3329 | | | |
| **3.0** | $A_0$ – 38 | 4072 | 1.00 | 3924 | | | |
| **4.0** | $A_0$ – 39 | 3901 | 1.00 | 3753 | | | |

| | | | | |
|---|---|---|---|---|
| **5.0** | $A_0 - 40$ | 4018 | 1.00 | 3870 |
| **Blank** | **Avg.** | 148 | 2.60 | |

**<u>Table S6</u>. Summary $D_M$ for Tables S4 and S5**

| [$HNO_3$] (M) | $D_{Am}$ Avg. | $D_{Am}$ Uncertainty (2σ) | $D_{Eu}$ Avg. | $D_{Eu}$ Uncertainty (2σ) | *SF* (Avg.) ($D_{Am}$ / $D_{Eu}$) | *SF* Uncertainty (2σ) |
|---|---|---|---|---|---|---|
| **0.25** | 0.4503 | 0.009 | 0.0076 | 0.002 | 59.2 | 15.6 |
| **0.50** | 0.9431 | 0.019 | 0.0139 | 0.002 | 67.8 | 10.8 |
| **0.75** | 1.850 | 0.038 | 0.0253 | 0.002 | 73.1 | 5.5 |
| **1.0** | 2.695 | 0.055 | 0.0326 | 0.002 | 82.6 | 4.8 |
| **2.0** | 10.25 | 0.316 | 0.0660 | 0.003 | 155 | 9.2 |
| **3.0** | 13.45 | 0.444 | 0.0885 | 0.003 | 152 | 7.6 |
| **4.0** | 9.006 | 0.267 | 0.0618 | 0.003 | 146 | 8.1 |
| **5.0** | 9.699 | 0.295 | 0.0724 | 0.003 | 134 | 7.0 |

**Table S7. Raw Data to Accompany Figure 2(c). Distribution of $^{241}Am^{3+}$ as a Function of Complexant Concentration in Kerosene/Exxal (50v/50v) Log-Log plot**

| [Ligand] (mM) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Am}$ (org./aq.) | $D_{Am}$ Avg. |
|---|---|---|---|---|---|---|---|
| **6.25** | org. - 1 | 702 | 1.19 | 681 | 101.3 | 0.2378 | 0.2424 |
| | org. - 2 | 741 | 1.16 | 720 | 103.9 | 0.2470 | |
| | aq. - 3 | 2885 | 1.00 | 2864 | | | |
| | aq. - 4 | 2936 | 1.00 | 2915 | | | |
| **12.5** | org. - 5 | 2102 | 1.00 | 2081 | 97.5 | 1.565 | 1.593 |
| | org. - 6 | 2165 | 1.00 | 2144 | 99.1 | 1.621 | |
| | aq. - 7 | 1351 | 1.00 | 1330 | | | |
| | aq. - 8 | 1344 | 1.00 | 1323 | | | |
| **25.0** | org. - 9 | 2992 | 1.00 | 2971 | 94.4 | 8.922 | 9.276 |
| | org. -10 | 3093 | 1.00 | 3072 | 96.9 | 9.630 | |
| | aq. -11 | 354 | 1.68 | 333 | | | |
| | aq. -12 | 340 | 1.71 | 319 | | | |
| **37.5** | org. -13 | 3138 | 1.00 | 3117 | 92.9 | 23.26 | 24.06 |
| | org. -14 | 3327 | 1.00 | 3306 | 98.3 | 24.86 | |
| | aq. - 15 | 155 | 2.54 | 134 | | | |
| | aq. - 16 | 154 | 2.55 | 133 | | | |
| **50.0** | org. -17 | 3222 | 1.00 | 3201 | 93.4 | 48.50 | 47.27 |
| | org. -18 | 3336 | 1.00 | 3315 | 96.8 | 46.04 | |
| | aq. -19 | 87 | 3.40 | 66 | | | |
| | aq. - 20 | 93 | 3.28 | 72 | | | |
| **62.5** | org. -21 | 3300 | 1.00 | 3279 | 95.0 | 71.28 | 81.64 |
| | org.-22 | 3425 | 1.00 | 3404 | 98.3 | 92.00 | |
| | aq. - 23 | 67 | 3.87 | 46 | | | |
| | aq. - 24 | 58 | 4.16 | 37 | | | |
| **75.0** | org. -25 | 3342 | 1.00 | 3321 | 95.8 | 110.7 | 110.9 |
| | org. -26 | 3354 | 1.00 | 3333 | 96.1 | 111.1 | |
| | aq. - 27 | 51 | 4.45 | 30 | | | |
| | aq. - 28 | 51 | 4.43 | 30 | | | |
| $A_0$ | $A_0$ - 29 | 3540 | 1.00 | 3519 | | | |
| $A_0$ | $A_0$ - 30 | 3501 | 1.00 | 3480 | | | |
| $A_0$ | Avg. | 3520.5 | 1.00 | 3499.5 | | | |
| Blank | Avg. | 21 | 6.84 | | | | |

**Table S8.** **Raw Data to Accompany Figure 2(c). Distribution of $^{154}Eu^{3+}$ as a Function of Complexant Concentration in Kerosene/Exxal (50v/50v) Log-Log plot**

| [Ligand] (mM) | Sample ID | CPM | Error (%) | Net CPM | Recovery (%) | $D_{Eu}$ (org./aq.) | $D_{Eu}$ Avg. |
|---|---|---|---|---|---|---|---|
| **6.25** | org. - 1 | 147 | 2.60 | -3[a] | 102.6 | -0.0009 | -0.0001 |
| | org. - 2 | 152 | 2.57 | 2[b] | 103.0 | 0.0006 | |
| | aq. - 3 | 3657 | 1.00 | 3507 | | | |
| | aq. - 4 | 3665 | 1.00 | 3515 | | | |
| **12.5** | org. - 5 | 198 | 2.25 | 48 | 103.3 | 0.0138 | 0.0125 |
| | org. - 6 | 189 | 2.30 | 39 | 103.3 | 0.0112 | |
| | aq. - 7 | 3629 | 1.00 | 3479 | | | |
| | aq. - 8 | 3639 | 1.00 | 3489 | | | |
| **25.0** | org. - 9 | 382 | 1.62 | 232 | 101.9 | 0.0714 | 0.0719 |
| | org. -10 | 389 | 1.60 | 239 | 103.7 | 0.0724 | |
| | aq. - 11 | 3399 | 1.00 | 3249 | | | |
| | aq. - 12 | 3452 | 1.00 | 3302 | | | |
| **37.5** | org. -13 | 712 | 1.19 | 562 | 102.0 | 0.1924 | 0.1899 |
| | org. -14 | 705 | 1.19 | 555 | 103.0 | 0.1873 | |
| | aq. -15 | 3071 | 1.00 | 2921 | | | |
| | aq. -16 | 3113 | 1.00 | 2963 | | | |
| **50.0** | org. -17 | 1072 | 1.00 | 922 | 100.6 | 0.3666 | 0.3680 |
| | org. -18 | 1084 | 1.00 | 934 | 101.4 | 0.3693 | |
| | aq. - 19 | 2665 | 1.00 | 2515 | | | |
| | aq. - 20 | 2679 | 1.00 | 2529 | | | |
| **62.5** | org. -21 | 1441 | 1.00 | 1291 | 99.1 | 0.6168 | 0.6307 |
| | org.-22 | 1485 | 1.00 | 1335 | 99.7 | 0.6446 | |
| | aq. - 23 | 2243 | 1.00 | 2093 | | | |
| | aq. - 24 | 2221 | 1.00 | 2071 | | | |
| **75.0** | org. -25 | 1785 | 1.00 | 1635 | 98.8 | 0.9407 | 0.9457 |
| | org. -26 | 1806 | 1.00 | 1656 | 99.5 | 0.9506 | |
| | aq. - 27 | 1888 | 1.00 | 1738 | | | |
| | aq. - 28 | 1892 | 1.00 | 1742 | | | |
| $A_0$ | $A_0$ - 29 | 3408 | 1.00 | 3257.5 | | | |
| $A_0$ | $A_0$ - 30 | 3425 | 1.00 | 3274.5 | | | |
| $A_0$ | Avg. | 3416.5 | 1.00 | 3266 | | | |
| Blank | Avg. | 150.5 | 2.58 | | | | |

**[a,b]Net CPM is below the critical limit ($L_C$) and therefore, reported as not detected, $L_C$ = 29 (95% confidence level). Upper limits ($L_U$) at the 95% confidence level: [a]$L_U$ = NA, [b]$L_U$ = 31.**

**Table S9. Summary $D_M$ for Tables S7 and S8**

| [Ligand] (mM) | $D_{Am}$ Avg. | $D_{Am}$ Uncertainty (2σ) | $D_{Eu}$ Avg. | $D_{Eu}$ Uncertainty (2σ) | *SF* (Avg.) ($D_{Am}$ / $D_{Eu}$) | *SF* Uncertainty (2σ) |
|---|---|---|---|---|---|---|
| **6.25** | 0.2424 | 0.005 | -- | -- | -- | 25 |
| **12.5** | 1.593 | 0.032 | 0.0125 | 0.002 | 128 | 7.1 |
| **25.0** | 9.276 | 0.278 | 0.0719 | 0.003 | 129 | 6.9 |
| **37.5** | 24.06 | 1.12 | 0.1899 | 0.005 | 127 | 9.5 |
| **50.0** | 47.27 | 3.31 | 0.3680 | 0.009 | 128 | 14 |
| **62.5** | 81.64 | 8.44 | 0.6307 | 0.014 | 129 | 15 |
| **75.0** | 110.9 | 14.1 | 0.9457 | 0.021 | 117 | 25 |