Supporting Information

A Simple Fluorescence Affinity Assay to Decipher Uranyl-Binding to Native Proteins

F. Laporte, Y. Chenavier, A. Botz, C. Gateau, C. Lebrun, S. Hostachy*, C. Vidaud, P. Delangle*
Author Contributions

F.L. Investigation:Lead; Writing – original draft:Supporting; peptide synthesis and purification, uranyl binding, data analysis:Lead
Y.C. uranyl binding, data analysis:Supporting
A.B. peptide synthesis and purification:Supporting
G.C. Peptide synthesis and purification:Lead
C.L. Peptide synthesis and purification, uranyl binding:Lead
S.H. Formal analysis:Lead; Writing – original draft:Lead
C.V. Formal analysis:Lead; Funding acquisition:Lead; Project administration:Lead; Validation:Lead
P.D. Formal analysis:Lead; Funding acquisition:Lead; Project administration:Lead; Supervision:Lead; Writing – original draft:Lead; Writing – review & editing:Lead
Table of Contents

Experimental Procedures ......................................................................................................................................... 3

Synthesis and characterization of compounds used in this study ........................................................................... 3
  General information ........................................................................................................................................... 3
  Nuclear magnetic resonance (NMR) .................................................................................................................. 3
  Electrospray ionization mass spectrometry (ESI-MS) ....................................................................................... 3
  High performance liquid chromatography (HPLC) .............................................................................................. 3
  Chemical synthesis ........................................................................................................................................... 4
  Peptide synthesis ............................................................................................................................................ 4

Metal-binding experiments ................................................................................................................................... 5
  General information ........................................................................................................................................... 5
  Preparation of solutions ................................................................................................................................... 5
  ESI-MS experiments ......................................................................................................................................... 5
  Fluorescence titrations .................................................................................................................................... 5
  Titration experiments of pS3 and pS4 with NaphP .......................................................................................... 6
  Competition experiments with NaphP ................................................................................................................ 6

Results and Discussion .......................................................................................................................................... 7
  Figure S1. ESI-MS spectra of peptides P^{11} and P^{22} in presence of 1 eq or 1.5 eq uranyl. ......................... 7
  Titration of an equimolar mixture of both peptides with 0-4 eq uranyl. ...................................................... 8
  Figure S2. Emission spectra of P^{22} and NaphP upon excitation at 280 nm and 344 nm in presence of 0-4 eq uranyl. .................................................................................................................................................................................. 9
  Figure S3. Emission spectra for excitation at 280 nm or at 344 nm of 2.1 µM solutions of P^{22}, NaphP or an equimolar mixture of both peptide. .................................................................................................................................................................................. 10
  Table S1. Sequences of peptides used in this study .......................................................................................... 11

References .............................................................................................................................................................. 13

Author Contributions .......................................................................................................................................... 13
Experimental Procedures

Synthesis and characterization of compounds used in this study

General information
Solvents and reagents were purchased from Alfa Aesar, Carlo Erba, Fluka, Sigma Aldrich and VWR, and were used without further purification. Natural amino acids were purchased from Merck Novabiochem and Bachem. Deuterated solvents were purchased from Euriso-top. All aqueous solutions were prepared from ultra-pure laboratory grade water that has been filtered and purified by reverse osmosis using Millipore Milli-Q cartridge system (resistivity 18.2 MΩ.cm at 25 °C). Thin Layer Chromatography (TLC) was performed on Silica gel 60 plates, coated with fluorescent indicator F254 from Merck Millipore. The detection was done under UV light, at 254 or 365 nm. Organic compounds were purified on a silica gel column with Silica gel Kieselgel 60 (0.040 0.063 mm, Merck), and characterized by 1H NMR and ESI-MS. NaphP was purified by preparative reverse phase high performance liquid chromatography (RP-HPLC), and purities were established by analytical HPLC analyses. All peptides were characterized by ESI-MS and 1H NMR.

Nuclear magnetic resonance (NMR)
NMR spectra were measured on a Bruker AVANCE 400 spectrometer at 298 K. The magnetic field homogeneity was achieved using 3D gradient shimming method. Chemical shifts were referenced to δTMS = 0.00 ppm (1H). Chemical shifts (δ) are reported in ppm and multiplicity is reported according to the following abbreviations: s (singlet), d (doublet), t (triplet) or m (multiplet), and coupling constants (J) are reported in Hz. For 1H NMR, assignments of individual resonances were done using 2D techniques (HH-COSY) when necessary.

Electrospray ionization mass spectrometry (ESI-MS)
Mass spectra were acquired on a LXQ-type Thermo Scientific spectrometer equipped with an electrospray ionization source and a linear trap detector. The LXQ calibration (m/z 50-2000) was achieved according to the standard calibration procedure from the manufacturer. Solutions were injected into the spectrometer using a syringe pump, at 5 μL.min⁻¹ flow rate. The ionization voltage was in the range of 2-6 kV. The capillary temperature of the LXQ was set to 250 °C for organic compounds and peptides complexes. The samples were analyzed in positive and/or negative modes.

High performance liquid chromatography (HPLC)
RP-HPLC was performed on a LaChrom system equipped with a UV monitor. UV chromator wavelength was set at 214 nm. Peptide samples (ca 1 mg.mL⁻¹ for analytical HPLC and 10 mg.mL⁻¹ for preparative HPLC) were prepared in a solvent or in a mixture of solvent identical to initial chromatographic conditions. Samples were filtrated on a 0.45 μm PTFE (polytetrafluoroethylene) filter before injection. Different types of stationary and mobile phases were used, depending on the compound to analyze. NaphP was analyzed by RP-HPLC using a Merck Purospher®STAR RP-18 endcapped column (250-4.6 i.d. mm, 5 μm), and purified on a Merck Purospher®STAR column (125-25 i.d. mm, 5 μm). Solvents used for RP-HPLC were: A = H₂O/TFA (v/v=99.925/0.075), solvent B = ACN/H₂O/TFA (v/v/v = 90/10/0.1). Applied flow rate was 1 mL.min⁻¹ for analytical HPLC and 15 mL.min⁻¹ or 30 mL.min⁻¹ for preparative HPLC.
Chemical synthesis

Compound S1 was synthesized from 1,8-naphthalic anhydride in 2 steps according to a published procedure.\textsuperscript{[1]}

Peptide synthesis

The syntheses of all peptides but NaphP were previously reported (see Table S1 for further details and references).

NaphP (Naph-(Ada)<sub>2</sub>PG(Ada)<sub>2</sub>A-NH<sub>2</sub>)

NaphP was synthesized by solid phase peptide synthesis (SPPS), following a procedure reported for proflavine derivatives.\textsuperscript{[2]}

Preparative HPLC: Merck Purospher® RP18a column 125 × 25 mm, 5 µm, elution gradient from A:B 5:95 to 100:0 in 15 min (where A = H<sub>2</sub>O/TFA (v/v=99.925/0.075) and B = ACN/H<sub>2</sub>O/TFA (v/v/v = 90/10/0.1)), flow rate 15 mL.min\textsuperscript{-1}, UV monitoring at 214 and 344 nm.

Isolated mass: 48 mg. Overall yield of pure peptide, assuming that the solid is NaphP∙2TFA (MW = 1253.95 g.mol\textsuperscript{-1}): 44 %

Analytical HPLC: (elution gradient from A:B 5:95 to 100:0 in 15 min and then to 0:100 in 5 min, UV monitoring at 214 nm): 100.0 % purity, t<sub>r</sub> = 7.0 min.

\textsuperscript{1}H NMR (500 MHz) chemical shifts (δ / ppm) for NaphP in H<sub>2</sub>O/D<sub>2</sub>O (9:1, v/v) at 298 K, 2.25 mM, pH 2. Signals assigned by TOCSY and ROESY 2D experiments.

| Residue | NH | Ha | Hβ | Others |
|---------|----|----|----|--------|
| GlyNaph | -  | 4.93 | -  | 8.42 (2H, H7/H8) 8.32 (2H, H7/H8) 7.65 (2H, H2/H3) |
| Ada<sup>*</sup> | 8.97 | 4.93 | 2.32 2.20 | 3.47 (Hγ) 4.02 (2 x CH<sub>2</sub>) |
| Pro | 4.45 | 2.33 2.03 | 2.03 (Hγ) 3.69 (Hβ) 3.77 (Hβ) |
| Gly<sup>*</sup> | 8.57 | 3.96 | -  | - |
| Ada<sub>2</sub><sup>*</sup> | 8.40 | 4.51 | 2.35 2.17 | 3.42 (Hγ) 4.02 (2 x CH<sub>2</sub>) |
| Ala | 8.41 | 4.30 | 1.40 | - |
| NH<sub>2</sub> | -  | -  | -  | 7.61 7.01 |

*The signals of the 2 Gly and the 2 Ada<sub>2</sub> could not be differentiated by 2D NMR and were assigned by analogy with the chemical shifts observed for the peptide PflP<sup>22</sup>.\textsuperscript{[2]}

(-)ESI-MS calculated for C<sub>49</sub>H<sub>46</sub>N<sub>10</sub>O<sub>16</sub>: experimental [M+H]<sup>+</sup> m/z 910.3, [M-2H]<sup>+</sup>\textsuperscript{2} 2 m/z 454.7, experimental [M+H]<sup>+</sup> m/z 910.3, [M-2H]<sup>+</sup>\textsuperscript{2} /2 m/z 454.7.

ε<sub>345nm</sub> (NaphP) = 10 964 L.mol<sup>-1</sup>.cm<sup>-1</sup>
**SUPPORTING INFORMATION**

**Metal-binding experiments**

**General information**

All aqueous solutions were prepared from ultra-pure laboratory grade water that has been filtered and purified by reverse osmosis using Millipore Milli-Q cartridge system (resistivity 18.2 MΩ.cm at 25 °C). Uranium standard solution was purchased from Spex Certi Prep. Uranium nitrate salts was provided by Atomic and Alternative Energies Commission (CEA). Commercial human apo-transferrin (apo-Tf, T2252, purity ≥98%), bovine serum albumin (BSA, A7030, purity ≥98 %) and bovine fetuin A (B-FETUA, F2379) were purchased from SIGMA Aldrich. Apo-Tf and BSA were extensively dialyzed against 50 mM TRIS, 150 mM NaCl pH 7.0 buffer, herein named " TRIS buffer", before use. B-FETUA was extensively dialyzed against the same TRIS buffer and then further purified by C Vidaud’s team (BIAM Laboratory, CEA Marcoule). Briefly, size exclusion chromatography (TSKgel®SW 3000 column, 21.5 x 300 mm, 4mL min⁻¹ flow rate) was used with TRIS buffer as the mobile phase, thanks to an ÅKTA Purifier 10 System (GE Healthcare, Vélizy Villacoublay, France) with on-line recording of UV absorbance. Bovine osteopontin (OPN) was purified by C Vidaud’s team in multiple steps from an OPN-enriched cow’s milk fraction (Lacprodan®OPN-10, Arla Foods Group, Viby, Denmark), according to the protocol previously published.[5] Protein purity was checked by Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) when needed. The final protein concentrations were calculated from their absorbances at 278 nm, using their molar extinction coefficients (ε = 80,000 M⁻¹cm⁻¹ for Apo-Tf, 43,824 M⁻¹cm⁻¹ for BSA, 19,840 M⁻¹cm⁻¹ for B-FETUA and 22,820 M⁻¹cm⁻¹ for OPN).

All pH measurements were registered with a Metrohm pH meter, using a combined macro or micro glass electrode. The electrodes were filled with 3 M KCl aqueous solution and calibrated using a 2 points calibration protocol (pH 4 and pH 7). Macro electrode was used to adjust pH of buffers and micro electrode to adjust pH of peptides solutions in UV cells.

**Preparation of solutions**

A uranyl stock solution (ca 10 mM) was prepared from uranyl nitrate hexahydrate in 0.01 M nitric acid. The precise uranyl concentration was determined by measuring the absorbance of an aliquot compared to an ICP Uranium Standard (1000 µg U /mL in 2% HNO₃) at λ = 415 nm. This solution was eventually diluted according to the experimental conditions and was used for all experiments. HEPES buffer (20 mM HEPES, 100 mM NaCl) was prepared by dissolving solid 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid and sodium chloride in ultrapure water and by adjusting the pH to 7.0 with KOH.

A stock solution of IDA (ca 100 mM) was prepared by dissolving solid iminodiacetic acid in ultrapure water. Precise concentration was determined by titration with a standard KOH solution (100 mM). Buffer solutions containing IDA were prepared by dilution of IDA solution (100 mM) in freshly made buffer. The pH was controlled and, if required, adjusted to 6.0, 7.0, 7.4, 8.0 or 8.5 with KOH.

Solutions of peptides and proteins

Peptides and proteins solutions were freshly prepared before use and their precise concentration was determined by their absorbance at their λ max.

**ESI-MS experiments**

Peptide solutions (ca. 100 µM) were prepared in ammonium acetate buffer (20 mM, pH 7). Aliquots of stock uranyl solution were added in order to prepare samples containing 1 and 1.5 eq. of UO₂⁺ per peptide. Mass spectra were recorded on a LXQ type THERMO SCIENTIFIC spectrometer equipped with an electrospray ionization source and a linear trap detector. Solutions were injected into the spectrometer at 10 µL/min flow rate. Ionization voltage and capillary temperature were about 2 kV and 250 °C, respectively. The source settings were the same (sheath gas, auxiliary gas, capillary voltage and tube lens) for all the samples to get comparable data.

**Fluorescence titrations**

Trp and Naph fluorescence quenching were followed by titration of peptide or protein buffered solutions (ca. 4 to 22 µM) containing 10 equivalents of IDA (ca 40 - 220 µM), with uranyl (from 0 to 4 eq., aliquots 0.1 eq.). The pH was measured at the beginning and at the end of the experiment to check pH stability during the titration experiments. Spectra were recorded on a LS50B spectrophotometer connected to a computer equipped with FLWINLAB 2.0. The measurements were performed at 298 K, in a 1 cm optical path length cell. Trp fluorescence titrations were performed with 280 nm excitation (excitation slit: 13 nm) and recorded respectively at 305 and 340 nm. Naph fluorescence titrations were performed with 344 nm excitation (excitation slit: 10-13 nm) and recorded at 380 nm. In each case, emission slit was adjusted (3.0-4.0 nm) to avoid signal saturation.

The conditional stability constants were extracted from the spectral data using the SPECFIT software.[4-6] The global β_{10} constants were calculated from these conditional constants and the pKa values of the ligands.
SUPPORTING INFORMATION

**Titration experiments of pS3 and pS4 with NaphP**

NaphP and ligand pSn (pS3 or pS4) mother solutions of approximatively 10 μM were prepared in a HEPES buffered solution adjusted at pH 7.0. Solutions containing both ligands (2 μM each) were prepared by dilution and titrated with uranyl (from 0 to 4 eq., aliquots of 0.1 eq.). The pH of the sample was measured at the beginning and at the end of the experiment to check pH stability during titration. Spectra were recorded on a Perkin Elmer LS55 Fluorescence Spectrometer with a pulsed xenon lamp and a photomultiplier tube R928 as detector, connected to a computer equipped with FL WinLab 4.0 software. The measurements were performed at 298 K, in a 1 cm optical path length cell. Naph fluorescence titrations were performed with 344 nm excitation (excitation slit: 10 nm) and recorded from 355 to 550 nm. Emission slit was adjusted (2.5 nm) to avoid signal saturation and an emission cut-off filter set at 350 nm was used to avoid second-order diffraction effects. The speedscan was set at 500 nm/min.

The conditional stability constants were extracted from the spectral data using the SPECFIT software.[4-6]

Definition of the constants given in Table 2 and Figure 2:

\[
\begin{align*}
UO_2^+ + P & \rightleftharpoons UO_2P \\
2 UO_2^+ + P & \rightleftharpoons (UO_2)^2P \\
UO_2 + 2 P & \rightleftharpoons UO_2(P)_2
\end{align*}
\]

\[
\beta_{11}^{pH} = K_{UO_2^+ P}^{pH} \\
\beta_{12}^{pH} = K_{UO_2(P)_2}^{pH}
\]

**Competition experiments with NaphP**

NaphP and ligand L (peptide or protein) mother solutions of approximatively 10 μM were prepared in a HEPES buffered solution adjusted at pH 7.0. Solutions containing both ligands (2 μM each) were prepared by dilution and 1 eq. uranyl was added. After equilibration, fluorescence spectra were recorded on a Perkin Elmer LS55 Fluorescence Spectrometer with a pulsed xenon lamp and a photomultiplier tube R928 as detector, connected to a computer equipped with FL WinLab 4.0 software. The measurements were performed at 298 K, in a 1 cm optical path length cell. Naph fluorescence titrations were performed with 344 nm excitation (excitation slit: 10 nm) and recorded from 355 to 550 nm. Emission slit was adjusted (2.5 nm) to avoid signal saturation and an emission cut-off filter set at 350 nm was used to avoid second-order diffraction effects. The speedscan was set at 500 nm/min. When possible, Trp fluorescence was followed upon excitation at 280 nm (emission/excitation slits: 4/10 nm) and recorded from 290 to 550 nm (speedscan set at 600 nm/min).
Results and Discussion

Figure S1. ESI-MS spectra of peptides P\textsuperscript{11} (110.5 µM, top) and P\textsuperscript{22} (94 µM, bottom) in presence of 1 eq or 1.5 eq uranyl (left and right, respectively), in 20 mM NH\textsubscript{4}OAc buffer (pH 6.9), in negative mode. ESI-MS signals of single peptides are highlighted in purple, 1:1 UO\textsubscript{2}:P complexes in orange, and 2:1 (UO\textsubscript{2})\textsubscript{2}:P complexes in green. For practical reasons, the experiment was performed with a deuterated version of P\textsuperscript{11} (bearing one d\textsuperscript{2}-Gly), resulting in a shift of m/z.
Figure S2. Emission spectra of P$_{22}$ (top row) and NaphP (middle row) upon excitation at 280 nm (left column) and 344 nm (right column) in presence of 0-4 eq uranyl. Bottom row: Titration of an equimolar mixture of both peptides with 0-4 eq uranyl.
**Figure S3.** Emission spectra for excitation at 280 nm (left, blue) or at 344 nm (right, red) of 2.1 µM solutions of P22 (light color), NaphP (medium color) or an equimolar mixture of both peptide (dark color). The sums of spectra separately measured for NaphP and P22 are displayed in dark, dotted lines for comparison to the equimolar mixture.
Figure S4. Correlation between the percentage of uranyl in the probe complex UO$_2$NaphP measured from fluorescence quenching data and calculated from the known values of the equilibrium constants with the program Hyss.[7] The dashed line represents a perfect accordance.

\[
\%\text{UO}_2\text{NaphP from fluorescence quenching} = \frac{[\text{UO}_2\text{NaphP}]}{[\text{UO}_2^{2+}\text{p}]} = \frac{Q}{Q(\text{UO}_2\text{NaphP})}
\]

with \(Q(\text{UO}_2\text{NaphP})\), the quenching of the probe in the complex UO$_2$NaphP (83%) measured in titrations such as presented in Figure 1B.
Table S1. Sequences of peptides used in this study

| Name   | Sequence                        | Ref |
|--------|---------------------------------|-----|
| P11    | Ac-W(Ada1)PG(Ada1)G-NH₂          | [8] |
| P22    | Ac-W(Ada2)PGi(Ada2)G-NH₂         | [9] |
| pS0:   | c( E R E PG E W E PG)            | [10]|    
| pS1:   | c( E RpSPG E W E PG)             | [11]|    
| pS2:   | c(pSR E PGpSW E PG)              | [12]|    
| pS2':  | c(pSR E PG E WpSPG)              | [12]|    
| pS3:   | c(pSE E PGpSWpSPG)               | [13]|    
| pS4:   | c(pSEpSPGpSWpSPG)                | [13]|    
| H8V:   | pSDEpSDE                        | [14]|    
| NaphP: | NaphGly-(Ada1)PG(Ada1)A-NH₂      | This study |
Table S2. Conditional equilibrium constant values for the UO$_2^{2+}$ complexes formed with the phosphate-rich cyclodecapeptides pS3 and pS4.

| Method 1 | Method 2 |
|----------|----------|
| pS3      | pS3      | pS4      | pS4      |
| log $\beta_{11}$ | 10.7(1) | 11.3(1) | 10.9(1) | 11.5(1) |
| log $\beta_{12}$ | 16.5(1) | 21.3(1) | 19.2(1) | 21.0(4) |
| log $\beta_{21}$ | 18(1)   | 16.9(1) | 17.0(2) | 16(1)   |
| log $K_1$ | 10.7(1) | 11.3(1) | 10.9(1) | 11.5(1) |
| log $K_{1U}$ | 5.8(2)  | 10.0(2) | 8.3(2)  | 9.5(5)  |
| log $K_{1L}$ | 7(1)    | 5.6(2)  | 5.5(3)  | 5(1)    |

**Method 1**: results reported in reference [13]. Constants were calculated from evolution of Trp fluorescence ($\lambda_{exc} = 280$ nm, $\lambda_{em} = 350$ nm) of cyclodecapeptides pS3 and pS4 upon addition of UO$_2^{2+}$ in 20 mM HEPES, 0.1 M NaCl at pH 7.4 in the presence of 10 equiv. of IDA with respect to peptide concentration. In the simulation of experimental data, complexes UO$_2$(P)$_2$ and UO$_2$P were considered fluorescent, while (UO$_2$)$_2$P was considered non fluorescent.

**Method 2**: results reported in this paper. Constants were calculated from evolution of Naph fluorescence ($\lambda_{exc} = 344$ nm, $\lambda_{em} = 380$ nm) of NaphP (2 µM), in presence of 2 µM pS3 or pS4, upon addition of UO$_2^{2+}$ in 20 mM HEPES, 0.1 M NaCl at pH 7. Only Naph-containing species, namely NaphP and UO$_2$NaphP, were considered fluorescent in the simulation of experimental data.

**Comparison of both methods.**

In method 1, all Trp-containing species are potentially fluorescent upon excitation at 280 nm. Therefore, different models were tested, with different assumptions on the fluorescence of all uranyl complexes. Depending on these assumptions, data fitting gave slightly different values for the constants. The model with complexes UO$_2$(P)$_2$, UO$_2$P considered fluorescent gave the best simulation of the experimental data. We thus made the hypothesis that (UO$_2$)$_2$P was non fluorescent.

A major asset of method 2, which uses naphthalimide fluorescence, is that only Naph-containing species are luminescent. Trp-containing species show no emission upon excitation at 344 nm. Therefore, no hypothesis about the luminescence spectra of the various species is made, making this second method significantly more robust. Method 2 confirms unambiguously the formation of three uranyl complexes: UO$_2$(P)$_2$, UO$_2$P and (UO$_2$)$_2$P. Indeed these three species are necessary to properly analyze the data. The values of the constants $\beta_{11}$ obtained by the two methods are similar (within the error), confirming that method 1 was also reliable for the determination of this constant. However, the constant for the species UO$_2$(P)$_2$ formed at the very beginning of the titration is quite imprecise with both methods due to the low concentration of this complex (log$K^{2L}$ is significantly lower than the other stepwise constants). Finally, the constants for the formation of (UO$_2$)$_2$P are more reliable with method 2 since no assumption is made on the fluorescent character of this species.
References

[1] A. Wu, Y. Xu, X. Qian, Bioorg. Med. Chem. 2009, 17, 592–599.
[2] L. Ancel, C. Gateau, C. Lebrun, P. Delangle, Inorg. Chem. 2013, 52, 552–554.
[3] L. Qi, C. Basset, O. Averseng, E. Quéméneur, A. Hagege, C. Vidaud, Metallomics 2014, 6, 166–176.
[4] H. Gampp, M. Maeder, C. J. Meyer, A. D. Zuberbühler, Talanta 1985, 32, 95–101.
[5] H. Gampp, M. Maeder, C. J. Meyer, A. D. Zuberbühler, Talanta 1985, 32, 257–264.
[6] H. Gampp, M. Maeder, C. J. Meyer, A. D. Zuberbühler, Talanta 1985, 32, 1133–1139.
[7] L. Alderighi, P. Gans, A. Ienco, D. Peters, A. Sabatini, A. Vacca, Coord Chem Rev 1999, 184, 311–318.
[8] F. Cisnetti, C. Lebrun, P. Delangle, Dalton Trans. 2010, 39, 3560–3562.
[9] F. Cisnetti, C. Gateau, C. Lebrun, P. Delangle, Chem. – Eur. J. 2009, 15, 7456–7469.
[10] C. Lebrun, M. Starck, V. Gathu, Y. Chenavier, P. Delangle, Chem. – Eur. J. 2014, 20, 16566–16573.
[11] M. Starck, F. A. Laporte, S. Oros, N. Sisommay, V. Gathu, P. L. Solari, G. Creff, J. Roques, C. Den Auwer, C. Lebrun, P. Delangle, Chem. – Eur. J. 2017, 23, 5281–5290.
[12] F. A. Laporte, C. Lebrun, C. Vidaud, P. Delangle, Inorg. Chem. 2015, 54, 11557–11562.
[13] F. A. Laporte, C. Lebrun, C. Vidaud, P. Delangle, Chem. – Eur. J. 2019, 25, 8570–8578.
[14] S. Safi, G. Creff, A. Jeanson, L. Qi, C. Basset, J. Roques, P. L. Solari, E. Simoni, C. Vidaud, C. Den Auwer, Chem. – Eur. J. 2013, 19, 11261–11269.

Author Contributions

Fanny Laporte: peptide synthesis and purification, uranyl binding, data analysis (lead), writing of original draft (supporting)
Yves Chenavier: uranyl binding, data analysis (supporting)
Alexandra Botz: peptide synthesis and purification (supporting)
Christelle Gateau: peptide synthesis and purification (lead)
Colette Lebrun: peptide synthesis and purification, uranyl binding, (lead)
Sarah Hostachy: formal analysis, writing of original draft (lead)
Claude Vidaud: funding acquisition, formal analysis, project administration, validation, (lead)
Pascale Delangle: funding acquisition, formal analysis, project administration, validation, writing of original draft (lead)