Electronic Supplementary Material (ESI) for Faraday Discussions.

Supplementary Information: Insight into binding in the K-channels from binding of K^+ Na^+ and water to N-methylacetamide

Mark J. Stevens* and Susan L. B. Rempe*

Center for Integrated Nanotechnologies, Sandia National Laboratories, Albuquerque, NM, 87185

E-mail: msteve@sandia.gov; slrempe@sandia.gov

Data Tables

Distances between atom pairs in the K^+ channel crystal structure 1K4C are given in Table S1. The enthalpies and entropies for the optimized structures for 1-8 8 NMA ligands are given in Table S2. For $2K^+$ and 8 NMA, the data are given in Table S3.

Table S1: Distances in Å between atom pairs in 1K4C K^+ channel. For the K atom, the index and site number (in parentheses) are given, OG is the hydroxyl oxygen of threonine, distances between amino acid oxygens describe separation among vertical layers.

atom 1	atom 2	r
K30 (1)	THR78:O	2.78
K30 (1)	GLY77:O	3.07
K31 (2)	GLY77:O	2.72
K31 (2)	VAL76:O	2.83
K32 (3)	VAL76:O	2.86
K32 (3)	THR75:O	2.71
K33 (4)	THR75:O	2.95
K33 (4)	THR75:OG	2.88
THR75:O	THR75:OG	3.05
THR75:O	VAL76:O	3.35
GLY77:O	VAL76:O	3.28
GLY77:O	THR78:O	3.44

Table S2: Change in enthalpy ΔH and entropy contribution $-T\Delta S$ for the reaction of Eq. 1 with $X = K^+$ and Na^+ as a function of ligand number n in kcal/mol. The temperature T is 298K.

n	$\Delta H(K^+)$	$-T\Delta S(K^+)$	$\Delta H(Na^+)$	$-T\Delta S$ (Na^+)
1	-31.0	7.1	-39.1	6.1
2	-56.3	15.0	-70.6	14.2
3	-74.3	21.5	-92.0	23.9
4	-102.9	39.8	-112.7	40.2
5	-119.8	52.0	-140.7	52.4
6	-138.6	68.5	-158.9	68.4
8	-175.5	91.9	-189.0	90.8

Table S3: For 2 cations with 8 NMA the change in enthalpy ΔH, entropy contribution $-T\Delta S$ and change in free energy ΔG for the reaction of Eq. 1 with $X = K^+$ and Na^+ in kcal/mol. For the single point calculation of ΔG for the Na^+ system, the entropy of the optimized system was used. The temperature T is 298K.

cation	ΔH	$-T\Delta S$	ΔG	calculation type
K^+	-195.9	104.2	-91.6	geometry optimized
Na^+	-234.9	101.5	-133.4	geometry optimized
Na^+	-189.6	101.5	-88.1	single point

Images

Images for all the optimized structures for K^+ and Na^+ are shown in Figures S1 and S2. Figure S3 shows images of the individual layers of the selectivity filter.[1] The positions are available as separate data files. These files are named Kn_NMAm.xyz and Nan_NMAm.xyz, where n gives the number of K or Na atoms in systems and m gives the NMA molecules. In addition, there is the file Na2_NMA8_SP.xyz that has the positions for the single point (SP) calculations of $2Na^+$ and 8 NMA.

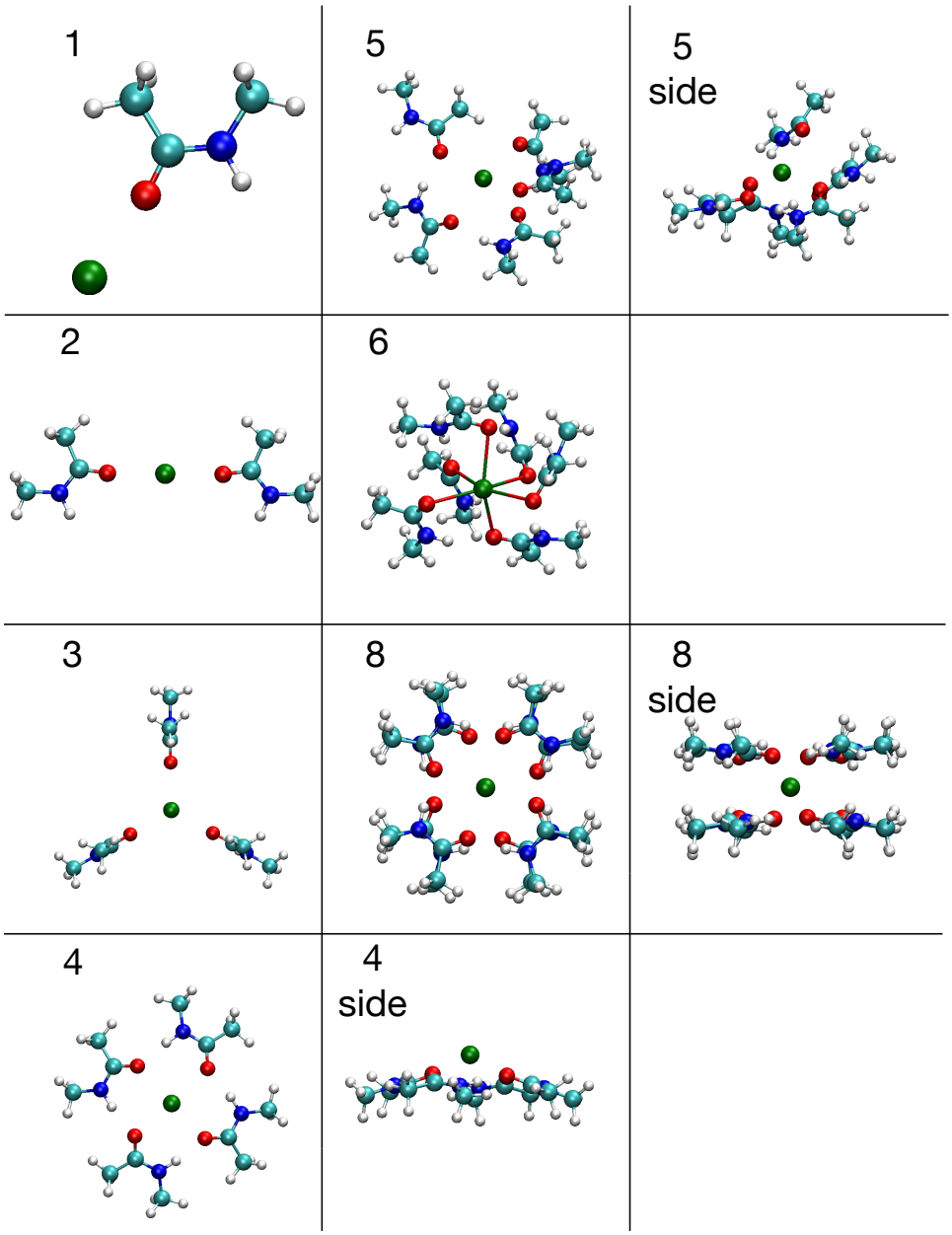

Figure S1: Images of K^+ complexes binding to n NMA ligands. The atom colors are: O red, C cyan, N blue, H white, and K green.

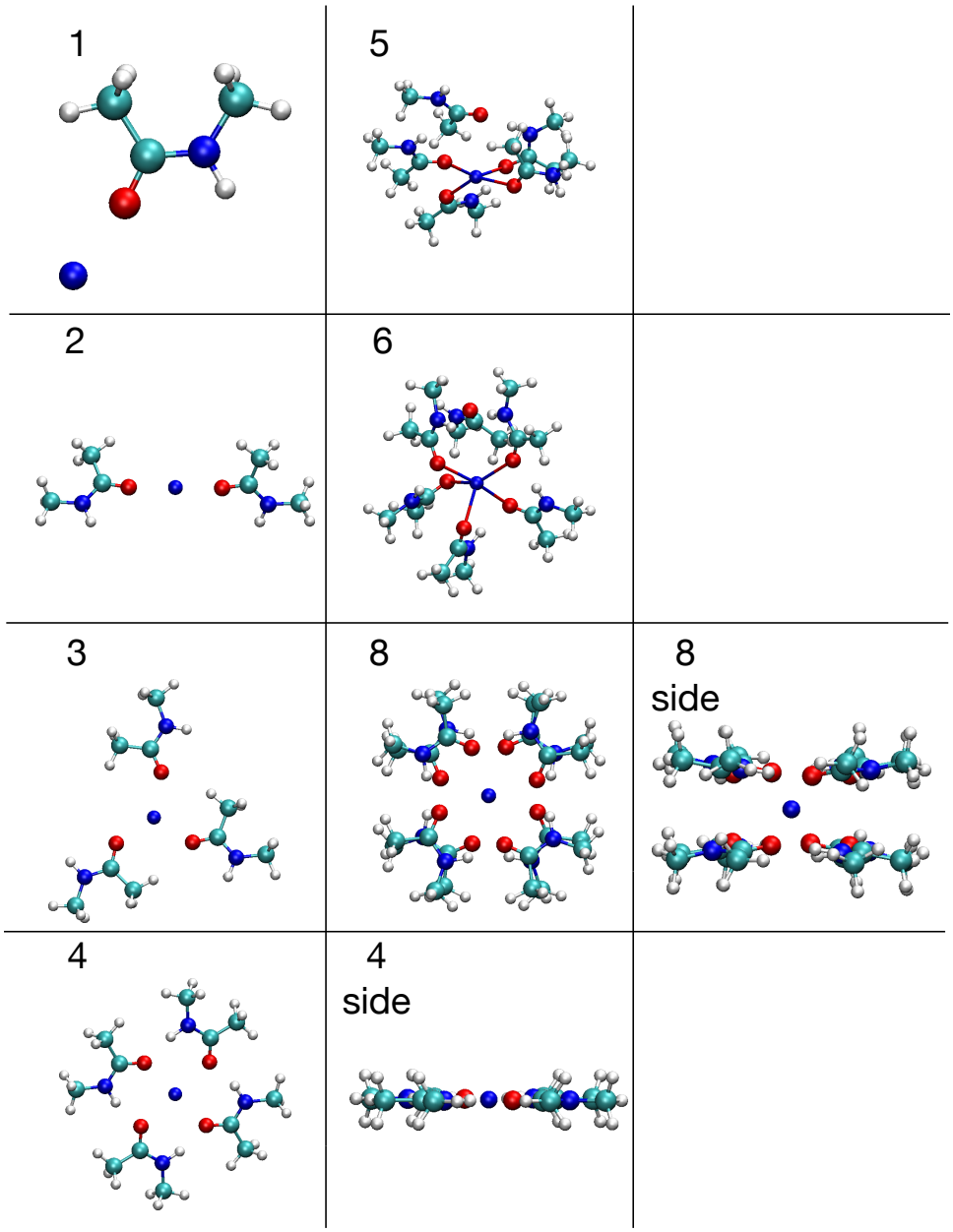

Figure S2: Images of Na^+ complexes binding to n NMA ligands. The atom colors are: O red, C cyan, N blue, H white, and Na blue.

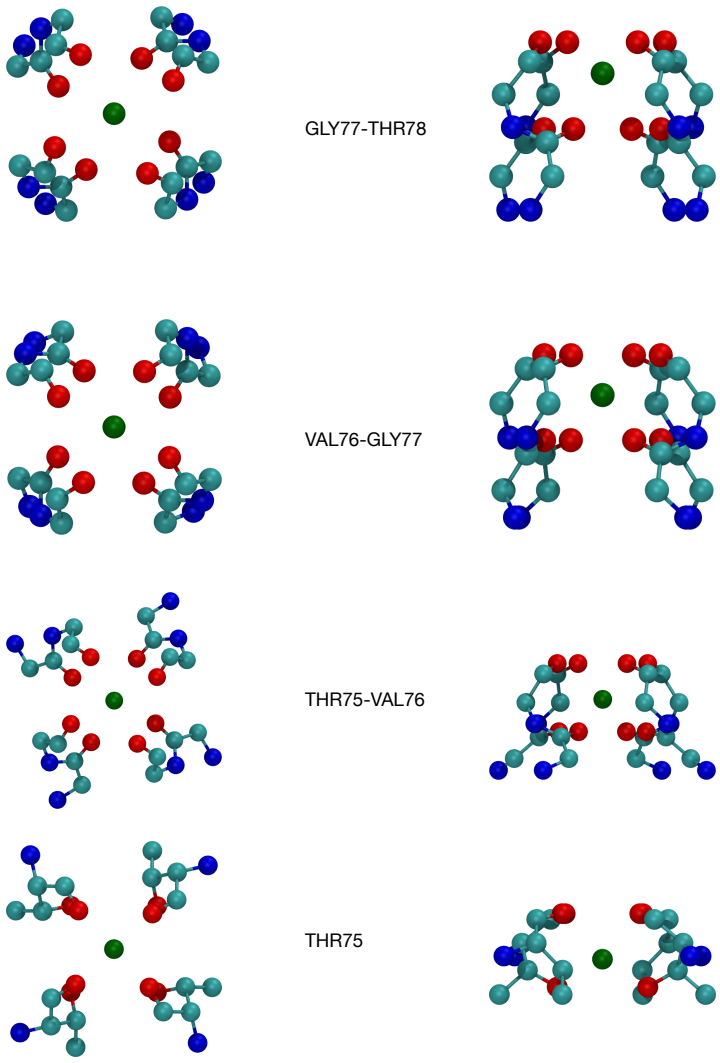

Figure S3: Images of the residue backbones for each of the 4 layers (binding sites S1 - S4 from top to bottom) of the selectivity filter of the 1K4C K-channel (left, top view; right, side view). Note that the oxygens of binding site S4 (bottom, THR75) are arranged differently from the others due to hydroxyl oxygens on the bottom layer.

References

(1) Zhou, Y.; Morais-Cabral, J.; Kaufman, A.; MacKinnon, R. Chemistry of Ion Coordination and Hydration Revealed by a K^+ Channel-Fab Complex at 2.0 Å Resolution. *Nature* **2001**, *414*, 43–48.