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Supporting Information

Synthesis of isomorphously substituted extra-large pore UTL zeolites

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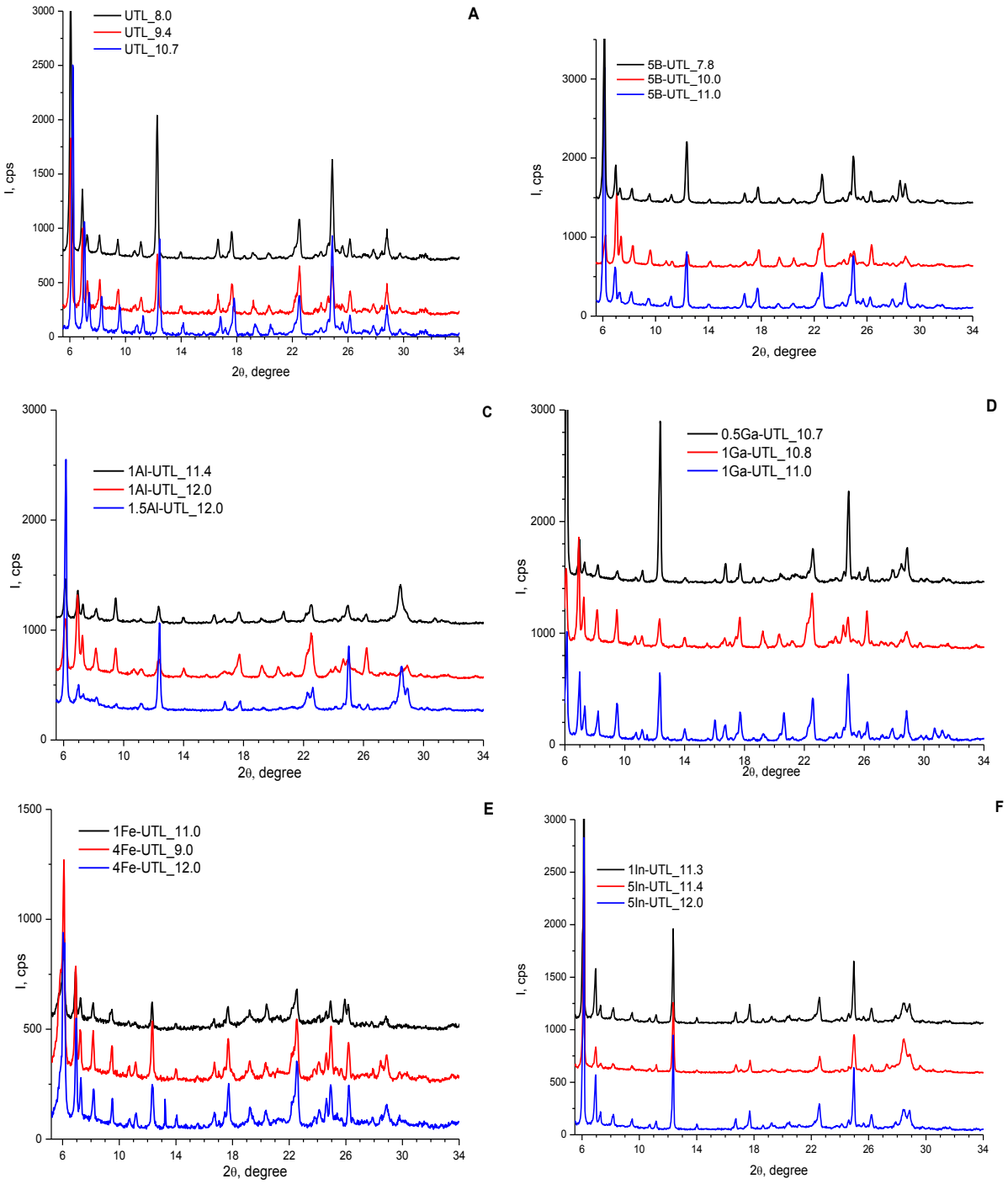

Figure SI-1. XRD patterns of **A**) germanosilicate, **B**) B-, **C**) Al-, **D**) Ga-, **E**) Fe- and **F**) In-containing zeolites with UTL topology, synthesized from reaction mixtures with different content of respective heteroelement and pH value (Si/Ge ≈ 2, 175 °C, 4 – 28 days)
Table SI-1. Details of the most representative synthesis of UTL zeolites.

Heteroelement	Samples	Reactant mixtures, moles					pH	Time, days	Phases
		SiO_2	GeO_2	$EO_{1.5}$	H_2O	SDA			
-	UTL_6.9/II	0.8	0.4	0	30	0.4	6.92	7	UTL+ *β-GeO_2*
	UTL_6.9/III	0.8	0.4	0	30	0.4	6.90	12	*β-GeO_2+UTL*
	UTL_7.3	0.8	0.4	0	30	0.4	7.30	6	UTL
	UTL_9.5	0.8	0.4	0	30	0.4	9.48	4	UTL
	UTL_12.1	0.8	0.4	0	30	0.4	12.1	4	UTL
	UTL_12.2	0.8	0.4	0	30	0.4	12.19	4	*UTL+STF*
	UTL_12.3	0.8	0.4	0	30	0.4	12.27	3	*STF*
B	1B-UTL_7.0/I	0.788	0.4	0.012	30	0.4	7.02	7	amor
	1B-UTL_7.0/II	0.788	0.4	0.012	30	0.4	7.05	13	α-quartz +*β-GeO_2*
	1B-UTL_7.8	0.788	0.4	0.012	30	0.4	7.82	7	UTL
	1B-UTL_9.5	0.788	0.4	0.012	30	0.4	9.50	7	UTL
	1B-UTL_11.8	0.788	0.4	0.012	30	0.4	11.82	7	UTL
	1B-UTL_12.1	0.788	0.4	0.012	30	0.4	12.09	6	UTL
	1B-UTL_12.2	0.788	0.4	0.012	30	0.4	12.17	6	*UTL+STF*
	5B-UTL_9.0	0.740	0.4	0.06	30	0.4	9.07	13	UTL
	11 B-UTL_11.6	0.680	0.4	0.120	30	0.4	11.64	8	UTL
	13 B-UTL_10.9	0.644	0.4	0.156	30	0.4	10.92	14	UTL
	15 B-UTL_10.1	0.62	0.4	0.18	30	0.4	10.12	17	*UTL+STF*
	15 B-UTL_11.0	0.62	0.4	0.18	30	0.4	11.0	15	*STF*
	15 B-UTL_10.0	0.62	0.4	0.18	30	0.4	10.0	12	*UTL+STF*
Fe	1Fe-UTL_7.2/I	0.788	0.4	0.012	30	0.4	7.22	9	amor
	1Fe-UTL_8.0/II	0.788	0.4	0.012	30	0.4	7.35	13	α-quartz +*β-GeO_2*
	1Fe-UTL_7.5	0.788	0.4	0.012	30	0.4	7.52	9	UTL
	1Fe-UTL_9.5	0.788	0.4	0.012	30	0.4	9.50	8	UTL
	1Fe-UTL_10.7	0.788	0.4	0.012	30	0.4	10.66	7	UTL
	1Fe-UTL_11.9	0.788	0.4	0.012	30	0.4	11.86	6	UTL
	1Fe-UTL_12.0	0.788	0.4	0.012	30	0.4	11.97	6	*UTL+STF*
	1Fe-UTL_12.0	0.788	0.4	0.012	30	0.4	12.05	5	*STF*
	3Fe-UTL_11.2	0.764	0.4	0.036	30	0.4	11.22	9	UTL
	5Fe-UTL_11.8	0.74	0.4	0.06	30	0.4	11.76	21	UTL
	6Fe-UTL_11.5	0.728	0.4	0.072	30	0.4	11.49	23	UTL
Ga	1Ga-UTL_7.1/I	0.788	0.4	0.012	30	0.4	7.12	9	amor
	1Ga-UTL_7.1/II	0.788	0.4	0.012	30	0.4	7.16	15	α-quartz +*β-GeO_2*
	1Ga-UTL_8.2	0.788	0.4	0.012	30	0.4	8.22	9	UTL
	1Ga-UTL_9.5	0.788	0.4	0.012	30	0.4	9.45	9	UTL
	1Ga-UTL_11.0	0.788	0.4	0.012	30	0.4	10.96	8	UTL
	1Ga-UTL_11.2	0.788	0.4	0.012	30	0.4	11.20	7	*UTL+STF*
	1Ga-UTL_11.8	0.788	0.4	0.012	30	0.4	11.80	7	*STF*
	1.5 Ga-UTL_10.8	0.782	0.4	0.018	30	0.4	10.80	20	*UTL*
	2 Ga-UTL_10.8	0.776	0.4	0.024	30	0.4	10.76	23	STF
	2 Ga-UTL_9.6	0.776	0.4	0.024	30	0.4	9.56	25	*UTL+STF*
	2 Ga-UTL_11.4	0.776	0.4	0.024	30	0.4	11.35	21	*STF*
Al	1Al-UTL_9.5/I	0.788	0.4	0.012	30	0.4	9.52	20	amor
	1Al-UTL_9.5/II	0.788	0.4	0.012	30	0.4	9.55	28	α-quartz +*β-GeO_2*
	1Al-UTL_11.4	0.788	0.4	0.012	30	0.4	11.38	20	UTL
	1Al-UTL_11.8	0.788	0.4	0.012	30	0.4	11.84	20	UTL
	1Al-UTL_12.0	0.788	0.4	0.012	30	0.4	12.03	20	UTL
	1Al-UTL_12.1	0.788	0.4	0.012	30	0.4	12.15	20	*UTL+STF*
	1Al-UTL_12.4	0.788	0.4	0.012	30	0.4	12.37	20	*STF*
	1.5Al-UTL_12.0	0.782	0.4	0.018	30	0.4	12.03	28	*UTL*
	2 Al-UTL_11.8	0.776	0.4	0.024	30	0.4	11.77	30	UTL+STF
	2 Al-UTL_12.0	0.776	0.4	0.024	30	0.4	12.04	28	*STF*
	2 Al-UTL_12.1	0.776	0.4	0.024	30	0.4	12.13	26	*STF*
In	1In-UTL_11.0/I	0.788	0.4	0.012	30	0.4	10.98	7	amor
	1In-UTL_11.0/II	0.788	0.4	0.012	30	0.4	11.08	13	α-quartz +*β-GeO_2*
	1In-UTL_11.3	0.788	0.4	0.012	30	0.4	11.31	7	UTL
	1In-UTL_11.5	0.788	0.4	0.012	30	0.4	11.51	7	UTL
	1In-UTL_12.0	0.788	0.4	0.012	30	0.4	11.98	7	UTL
	1In-UTL_12.1	0.788	0.4	0.012	30	0.4	12.1	7	*UTL+STF*
	1In-UTL_12.2	0.788	0.4	0.012	30	0.4	12.23	6	*STF*
	3In-UTL_11.3	0.764	0.4	0.036	30	0.4	11.30	21	UTL
	5 In-UTL_11.4	0.74	0.4	0.06	30	0.4	11.41	18	UTL
	6 In-UTL_12.0	0.728	0.4	0.072	30	0.4	11.96	14	UTL
	7 In-UTL_12.0	0.716	0.4	0.084	30	0.4	12.00	14	*STF*
	7 In-UTL_11.9	0.716	0.4	0.084	30	0.4	11.87	17	*UTL+STF*

Table SI-2. Chemical composition and acid site concentrations for UTL zeolites

Sample	C (E), mol. %	C (Brønsted a.c.), μmol/g	C (Lewis a.c.), μmol/g	∑ (a.c.), μmol/g
UTL_8.0	-	-	42	42
5B-UTL_7.8	1.0	16	40	56
1Al-UTL_12.0	2.3	49	48	97
1Ga-UTL_8.2	2.3	11	72	83
2Fe-UTL_8.4	2.7	7	74	81
5In-UTL_12.0	2.3	6	71	77

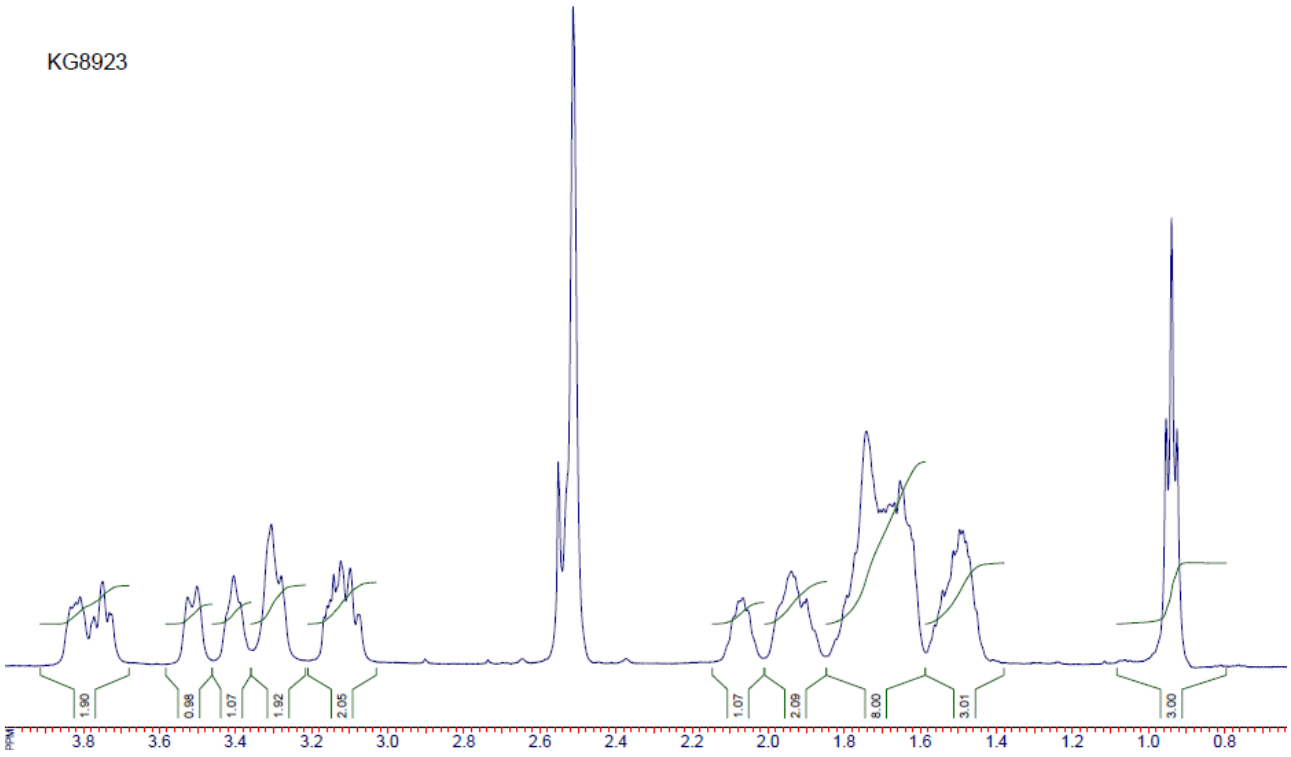

Figure SI-3. ^{1}HNMR spectra for 7-ethyl-6-azoniaspiro [5.5] undecane bromide.