Chemical analyses of waters from Sokoto Basin

[Results in milligrams per liter except as indicated. Location: Name of town, village, or milepost in or near which corresponding borehole, well, or water-sampling point is located. Borehole: Serial numbers are assigned by Geological Survey of Nigeria (GSN) to all boreholes in northern Nigeria; D, dug or open well; S, spring; SW, surface-water sample. Iron: Iron is in solution except when designated "*," precipitated, or "t," total. Fluoride: Tr., trace. Dissolved solids: By calculation, including silica, except when designated "a," by determination, or "b," by calculation, less silica. Remarks: A, sample from artesian aquifer; B, sample from 905 to 920 ft; I, sample from Illo Formation; C, sample from 70 to 80 ft; W, sample from shallow water-table aquifer. Analyses of samples from Gwandu Formation by D. J. O'Leary, R. T. Kiser, John Adesuyi, and J. A. Akingbehin, Geological Survey of Nigeria, Kaduna South, Nigeria; all others by R. T. Kiser, J. A. Akingbehin, and John Adesuyi at the same laboratory]

Location	Borehole	Date of collection	Temperature (°C)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_4)	Boron (B)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Percentage sodium	Sodium-absorption-ratio	Remarks
Gundumi Formation																								
Rabah	GSN 2490	8-65	----	15	0.07	----	12	2.2	25	8.5	83	29	2.0	0.2	0.3	0.1	137	39	0	210	8.4	52	1.7	A
Dange	3512	9-65	----	13	4.0 p	----	4.8	.5	3.3	1.1	3	21	1.0	.1	.4	.1	46	14	12	58	5.1	31	.4	A
Sabon Birni	3513	12-65	32	15	----	----	2.2	.4	74	3.8	158	14	8.5	.5	.5	.0	205	7	0	332	8.7	93	12	A
Isa	3514	12-65	31	15	----	----	4.2	.6	265	8.0	175	102	238	.6	.5	1.0	728	13	0	1,240	8.7	96	32	A
Gusau-Sokoto road, mile 109+4,400 ft	3519	4-66	----	13	32 p	1.8	5.6	3.2	3.2	2.6	0	48	1.5	.3	0	.0	79	27	27	160	3.7	14	.3	A
Gusau-Sokoto road, mile 105+800 ft	3520	4-66	----	14	----	----	1.0	.4	1.2	1.8	2	6.7	2.0	.1	.0	0	28	4	2	24	5.1	28	.2	A
Gusau-Sokoto road, mile 95+200 ft	3522	8-65	----	17	.03	----	2.0	.2	5.8	8.5	19	12	2.0	.0	.3	.1	57	6	0	50	7.4	42	1.0	A
Gusau-Sokoto road, mile 83	3524	5-66	33	14	.03	----	9.6	.5	2.1	2.4	36	.6	1.5	----	.3	.0	49	26	0	63	7.8	13	.2	A
Gusau-Sokoto road, mile 73	3526	5-66	33	21	14 t	.00	16	5.8	26	24	156	7.7	2.5	----	.1	.0	187	64	0	299	8.7	37	1.4	A
Gusau-Sokoto road, mile 93+3,400 ft	3703	5-66	33	13	14 t	.10	3.2	.5	7.3	10	38	5.6	1.0	.1	.1	.1	60	10	0	86	7.6	41	1.0	A
Girawsi	3704	8-66	36	12	3.7 t	.07	18	4.6	20	8.0	100	32	5.5	.2	.1	.0	150	64	0	250	7.5	37	1.1	A, B
Mungadi	3707	9-66	30	13	15 t	.10	23	3.3	20	3.5	22	69	19	.2	.6	.0	163	71	53	280	6.6	37	1.0	A, I
Kaloye	3708	3-67	34	13	.00	----	292	21	800	27	134	116	1,640	.8	----	.9	2,980	815	705	4,900	7.7	67	12	A
Sainyinan Daji	3709	4-67	35	15	8.4 p	.11	17	3.3	20	4.8	66	43	3.0	.2	.0	.0	135	56	2	223	6.8	41	1.2	A
Rima Group																								
Birnin Kebbi	GSN 2483	11-61	----	18	0.04	0.8	35	23	12	10	167	71	5.2	Tr.	7.5	----	265	183	46	428	6.5	12	0.4	A
Rabah	2488	12-62	----	19	.03	----	51	12	14	12	115	88	16	Tr.	3.9	----	275	175	31	----	6.4	14	.5	A
Sokoto GRA 2	2859	6-66	32	17	6.1 p	.08	26	5.6	5.5	4.6	89	26	3.0	0.3	1.1	0.0	133	88	15	200	8.0	11	.3	A
Balle	3053	8-63	37	----	----	----	137	53	98	23	238	588	11	----	4.4	----	1,090	559	364	1,300	7.5	27	1.8	A
Sokoto GRA 4	3505	6-66	33	3.6	4.4 p	.32	19	2.6	2.1	5.4	73	9.4	.0	.5	.0	.0	79	58	0	135	7.2	9	.1	A
Bodinga	3508	7-65	33	18	----	----	15	1.6	9.5	1.6	20	23	1.5	.0	29	.0	109	44	28	158	7.4	31	.6	A
Shuni	3511	8-65	----	17	.06	----	23	2.8	3.4	7.1	18	67	3.0	.6	.3	.2	133	69	54	178	7.5	9	.2	A
Gusau-Sokoto road, mile 120+600 ft	3517	12-65	----	12	----	----	4.0	.5	1.7	4.7	16	11	2.2	.2	.1	.0	44	12	0	52	7.5	16	.2	A
Girawsi	3704	7-66	32	19	6.4 p	.24	36	7.3	28	5.7	93	93	7.0	.8	.3	----	243	120	44	390	7.0	32	1.1	A, C
Do	3705	9-66	29	14	3.7 p	.07	15	3.0	3.6	4.2	60	16	1.5	.4	.5	.0	88	50	1	145	8.1	13	.2	A
Sokoto ECN power station	3706	8-66	32	16	14 p	.24	32	4.1	4.4	5.2	8	100	2.5	.2	1.4	.1	170	97	90	255	6.0	8	.2	A
Kaloye	3708	3-67	35	15	.00	.00	18	4.4	157	5.5	291	102	48	1.4	2.2	.5	497	63	0	845	7.5	83	7.5	A
Dange	D	8-66	31	12	.00	.00	44	2.9	11	16	100	42	17.0	.4	23	.0	217	122	40	370	7.5	14	.4	W
Dogwandaji	D	6-66	32	15	.00	.00	28	2.9	4.3	4.3	83	10	2.5	.1	17	.0	125	82	14	200	7.9	10	.2	W
Kalambaina Formation																								
Bodinga	D	7-66	32	15	0.06	0.00	38	7.5	19	28	140	17	26	0.7	40	0.0	260	126	12	455	7.9	20	0.7	W
Chimola	D	9-65	----	10	.04	----	214	43	81	421	82	123	194	.2	1,210	.2	2,340	710	643	3,150	8.2	12	1.3	W
Dange	D	8-66	31	19	.00	.00	78	5.2	19	34	169	36	45	.8	84	.0	400	216	85	660	8.1	14	.6	W
Kware	D	7-66	----	22	.00	.00	50	5.4	2.9	4.3	155	2.5	3.0	.2	28	.0	194	147	20	320	7.5	4	.1	W
Mungadi	D	9-66	31	35	.01	.00	26	11	19	74	104	44	34	.3	89	.0	383	109	24	580	8.2	17	.8	W
Sokoto	D	8-66	31	24	.00	.00	59	4.6	3.0	2.6	180	4.9	3.5	.2	21	.0	212	166	18	355	7.7	4	.1	W
Tambawel	D	9-66	30	13	.00	.08	18	5.4	8.8	28	20	7.2	16	.0	97	.0	203	67	50	315	7.2	16	.5	W
Angwan Tudu	S	4-66	----	27	.44p	.00	42	33	8.4	2.8	168	80	5.0	.7	35	.0	318	239	100	505	8.3	7	.2	
Gwandu Formation																								
Birnin Kebbi	GSN 2481	11-61	----	17	0.08	0.2	17	12	13	12.9	124	18	5.6	----	7.6	----	151a	92	0	253	6.6	21	0.6	A
Argungu	2485	3-65	----	----	----	----	8.0	2.0	3.4	2.0	35	2.5	2.0	----	7.7	----	45b	28	0	82	7.5	20	.3	A
Rafin Kubu	2499	1-65	----	----	----	----	6.2	4.8	7.1	3.0	35	21	2.0	----	2.7	----	64b	36	8	130	7.5	28	.5	A
Bacaka	2674	1-65	38	----	----	----	9.2	1.3	50	3.0	149	5.0	8.0	----	6.6	----	157b	29	0	266	7.5	77	3.8	A
Balle	3051	6-63	27	8.7	.12	.12	18	5.8	4.6	6.2	63	34	15	0.0	5.5	----	134, 117a	68	16	----	7.2	10	.2	A
Do	3054	1-65	30	----	----	----	10.3	10.3	7.3	3.0	90	3.0	6.0	----	3.3	----	123b	69	----	165	7.2	18	.4	A
Do	3055	1-66	31	----	----	----	6.2	6.5	5.8	2.5	59	4.5	4.0	----	.9	----	61b	43	0	115	7.3	21	.4	A
Kurdula	3056	1-65	37	----	----	----	11	11	32	4.5	124	21	6.0	----	6.6	----	153b	64	0	278	7.4	50	1.8	A
Tangaza	3059	3-65	----	----	----	----	3.1	.4	2.0	.2	3.0	4.1	2.0	----	8.8	----	22b	10	8	33	7.5	30	.3	A
Yeldu	3063	3-65	----	----	----	----	12.3	5.8	22	4.0	117	4.3	4.0	----	9.9	----	120b	54	0	205	7.4	45	1.3	A
Karfin Sarki	3069	1-65	34	----	----	----	8.0	6.6	11	4.0	67	14	4.0	----	6.6	----	87b	47	0	159	7.5	32	.7	A
Ruawuri	3070	3-65	----	----	----	----	8.0	1.1	10	1.5	20	24	2.0	----	7.1	----	64b	25	8	96	7.3	45	.8	A
Safia	3501	3-65	----	----	----	----	4.1	.1	2.4	.9	7.3	7.4	----	----	7.1	----	25b	10	4	42	7.3	30	.3	A
Danzomu	3502	3-65	----	----	----	----	9.3	2.4	3.7	1.7	15	23	2.0	----	8.9	----	58b	33	20	88	7.2	19	.3	A
Balle	D	7-66	32	13	.02	.00	5.6	1.2	5.5	.0	9	.5	2.5	----	29	0.0	64	19	12	80	6.9	35	.6	W
Gwandu	D	6-66	31	11	.00	.00	9.6	.7	2.6	.0	34	.3	.5	----	11	.0	56	27	0	79	7.5	15	.2	W
Kurdula	D	7-66	31	25	.04	.00	14	7.5	30	26.0	52	16	16	----	111	.0	272	66	24	405	7.7	40	1.6	W
Kwakwara	D	5-66	----	18	.21	.00	6.4	1.7	3.9	10.0	31	1.3	4.5	----	10	.0	71	23	0	90	7.4	19	.4	W
Yeldu	D	6-66	32	13	.01	.00	2.2	.6	2.3	2.7	13	.2	.5	----	5.3	.0	33	8	0	35	7.3	30	.4	W
Surface water																								
River Niger at Dole (in Niger)	SW	5-66	----	18	0.14	0.00	6.4	1.9	8.0	4.4	40	9.4	4.0	0.2	0.3	0.0	73	24	0	100	7.8	37	0.7	
Lake Kalmalo	SW	4-66	----	5.1	.16	.00	24	10	7.1	23	150	2.8	6.5	1.6	2.2	----	157	103	0	300	8.3	10	.3	
River Rima at Sokoto	SW	9-66	30	7.3	----	----	8.0	3.9	3.9	3.2	46	2.1	.5	----	.6	----	50	28	0	78	7.7	21	.3	
River Sokoto at Sokoto	SW	9-66	30	7.3	----	----	5.2	.5	3.3	3.6	27	3.0	.0	----	.0	----	36	15	0	49	7.5	26	.4	
River Shella at Kalgo	SW	9-66	29	24	.03	.00	20	4.9	16	4.4	111	15.0	3.5	.2	.2	.0	143	70	0	220	7.2	32	.8	
River Zamfara at Jega	SW	9-66	29	6.6	----	----	4.4	1.0	2.4	3.6	23	2.3	.5	----	.9	----	33	15	0	44	7.4	20	.3	
Basement complex																								
Tunfafia (mile 54¼)	GSN 3702	4-66	----	41	----	----	19	24	63	2	340	4.1	2.0	0.1	5.7	----	328	148	0	500	8.2	48	2.3	W
Gusau-Sokoto road, mile 52	?	3-57	27	24	12 p	0.01	27	9.6	4.3	3.0	144	.5	1.0	----	.0	----	142	107	0	250	7.4	8	.2	W