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Recent Study of Ground Water Quality of Sambalpur Municipal Corporation, Odisha, India

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ABSTRACT
Thirty three different locations like Industrial, Educational, Cultural, Business area in Sambalpur Municipal Corporation of Odisha, India, indicate pressure on unconfined aquifer condition at a depth varying from 0.6 to 40m below a thin soil horizon. The ground water sample collected from good numbers of bore wells during pre-monsoon period of 2016 were analyzed for different physico-chemical parameter (hardness, Calcium , Sodium, Potassium, Magnesium, Fluoride, sulphate, Carbonate, Alkalinity, COD, DO, etc.) including their suitability for various process. The qualities of ground water sample of the study area indicate the dominance of host rocks as the controlling factor for chemical composition. Analysis of results showed that the ground water is fit for drinking as pert standard prescribed by World Health Organization.

Keywords: Amphibolites, Chemical oxygen demand, Dissolved oxygen, Hardness of water, Petrographic analysis, Physico-chemical parameters, Predominant rock, Sericitization.

I. INTRODUCTION

The importance of resources evaluation for ground water has increased many folds in the last three decades because of rapid industrialization and urbanization as over dependent on ground water. The increasing human interaction with nature has severely affected by the consumable surface water regulating the ground water as a new source. It is no secret that most of rural areas of India even towns as cities do not have access the safe drinking water , although the country has to made spectacular program in certain areas of sciences and technology during the last five decades after independence. Sambalpur Municipal Corporation is a new corporation declared by government in the year 2014. It is mainly an educational town Burla, having Technical University, Sambalpur University, Medical college and research, Mahanadi Coal Field's Computer Office, etc. Hirakud is an old Industrial town with Hindalco Industries, Hira Cables, Blue Fox, etc, developed after the construction of largest Hirakud Dam in 1954, this Sambalpur and Hirakud Cultural town since 1000 year the heart place of Western Odisha having population more than 5,00,000. The city ($20^0$28'-21031'N and 830-83055'E) has a typical monsoon climate and main drainage system is controlled by the river Mahanadi with an undulated topography. The area in marled by a thin soil profile of primarily sandy soil.The predominate rock type of the area is granite type. Suggest to multi component body [1]. The secondary features due to the deformation weathering and alteration of parent rocks are main aquifer forming factors besides the primary structural and physico-chemical features.

II. MATERIAS AND METHODS

Thirty three ground water samples in triplicates were collected during the pre-monsoon period of 2016 from the bore wells in one liter precleaned polyethelylene bottles as per standard procedures [2]. The locations of sampling sites in the areas are given namely (see Figure-1). Temperature, pH, conductance, dissolved oxygen and dissolved CO_2 samples were collected and determined on the spot and other physico-chemical parameters were estimated [3], [4]. The major rock types were demarcated and petro graphic analysis was done with help of point counter.

Table 1.A.: Physico-chemical parameters of different bore wells.

Bore well number & location	pH moles/L	EC μ υ/cm	Temp ^{O}C	TDS ppm	TH ppm	TA ppm	DO ppm	COD ppm
1. Village-1	7.62	385	31.0	298	233	99	3.8	27.18
2. Township-1	7.75	888	31.9	411	411	121	2.4	31.11
3.Vimsar Medical College	7.41	896	33.1	455	455	111	2.2	28.7
4. Market	7.81	705	32.3	298	298	111	3.1	29.6
5. Township-2	7.70	828	33.2	388	388	136	4.6	41.3
6. Sambalpur University	7.91	721	32.8	121	121	88	4.8	38.7
7. Katapali	7.66	411	30.9	321	321	190	3.9	42.2
8. Golgunda	7.91	427	30.8	375	375	107	2.9	29.7
9. Village-2	8.02	626	31.7	611	611	109	4.1	24.7
10. VSSUT	7.94	640	34.2	421	421	100	4.2	18.8
11. MCL Office	7.69	711	36.1	555	555	99	4.0	35.2
12. HINDALCO	7.88	999	29.9	281	281	68	4.5	31.7
13. Blue Fox Industry	7.38	712	30.5	79	66	71	3.8	34.4
14. Village-3	8.21	1096	31.2	211	102	88	2.4	38.8
15. Remed	7.81	921	33.3	311	188	93	2.3	42.2
16. Bareipali	7.77	412	32.1	618	300	126	3.7	41.1
17. Airport	8.31	1235	34.6	325	101	91	4.1	39.1
18. Village-4	7.21	918	35.1	428	161	121	4.0	19.2
19. Government. Hospital	7.90	1301	32.3	602	189	111	3.8	22.2
20. Tangerpali	7.66	428	31.9	598	201	100	2.9	40.6
21. GM university	8.40	511	32.9	611	222	106	4.2	35.7
22. Gopalmal	7.31	611	30.8	583	188	101	3.8	39.1
23. Danipali	8.61	728	31.0	621	206	99	3.8	40.4
24. Durgapali	8.57	915	32.0	310	108	98	4.1	32.2
25. Budharaja	7.91	710	30.8	421	133	81	4.2	28.4
26. New Township	7.92	428	32.3	619	196	71	4.1	99.9
27. Modipara	7.69	555	32.4	311	109	61	4.61	31.1
28. Police Hospital	7.88	729	30.8	199	98	51	4.02	11.8
29. Daleipara	7.90	1029	34.1	218	107	61	4.3	28.8
30. Brooxhill	7.61	621	33.3	701	206	99	4.2	39.9
31. Charbhati	7.66	778	32.6	311	109	69	4.1	34.6
32. Binakhandi	7.67	926	31.0	429	211	90	4.11	33.3
33. Maneswar	7.66	710	32.8	512	166	100	4.21	31.01

Table 1.B.: Physico-chemical parameters of different bore wells.

Bore well number & location	Ca^{2+} ppm	Mg^{2+} ppm	Na^{+} ppm	K^{+} ppm	Cl^{-} ppm	SO_4^{2-} ppm	F^{-} ppm	CO_3^{2-} ppm	HCO_3^{-} ppm	CO_2 ppm
1. Village-1	7.9	8.2	11.2	11.9	28	0.8	1.01	3	40	12
2. Township-1	11.2	8.1	18.6	14.6	64	2.8	1.2	18	46	11
3.Vimsar Medical College	8.8	7.1	6.4	16.7	61	0.9	0.9	22	28	18
4. Market	18.7	6.3	18.6	15.4	80	1.1	0.6	35	111	14
5. Township-2	10.6	5.8	18.9	9.9	18	2.6	0.71	0	96	9
6.Sambalpur University	19.2	2.6	3.8	11.8	99	0.7	0.88	0	215	11
7. Katapali	9.9	7.2	28.6	17.1	103	3.4	0.88	7	111	8
8. Golgunda	8.8	7.6	42.2	20.4	58	2.1	0.99	22	201	8
9. Village-2	10.2	9.1	52.6	22.2	118	0.9	1.36	0	168	11
10. VSSUT	108.6	10.1	58.6	23.0	129	4.6	0.91	18	205	16
11. MCL Office	242.6	11.6	61.6	16.8	68	4.2	1.06	41	99	11
12. HINDALCO	99.6	18.2	80.1	18.8	52	4.4	2.6	32	106	12
13. Blue Fox Industry	118.2	10.8	27.2	16.1	88	0.9	0.7	16	96	14
14. Village-3	98.2	10.9	52.6	18.2	128	1.1	1.88	28	111	10

15. Remed	212.2	14.6	61.2	19.2	108	1.6	1.96	4	208	9
16. Bareipali	188.6	5.6	52.2	22.4	180	2.1	1.11	26	211	11
17. Airport	99.6	9.9	33.3	24.1	99	3.6	1.1	40	68	17
18. Village-4	252.6	11.7	18.6	9.1	108	1.1	1.02	41	206	18
19. Government. Hospital	411.6	118.2	7.2	11.1	142	1.1	0.7	47	211	14
20. Tangerpali	512.6	14.2	8.1	9.2	102	0.9	0.98	18	168	11
21. GM university	99.6	7.2	18.6	16.4	96	0.8	0.96	35	252	10
22. Gopalmal	128.6	6.4	22.6	8.8	180	2.4	0.9	42	92	9
23. Danipali	168.2	5.8	6.6	4.5	176	2.6	0.7	47	88	14
24. Durgapali	381.5	4.8	16.4	5.5	96	0.5	0.68	52	191	16
25. Budharaja	377.2	6.8	9.1	4.2	92	0.6	1.6	18	111	14
26. New Township	199.6	8.8	11.1	6.4	191	1.2	2.1	22	29	11
27. Modipara	198.2	10.2	18.2	8.8	106	1.1	1.8	46	69	12
28. Police Hospital	311.2	10.9	4.6	4.6	108	1.0	1.1	51	120	9
29. Daleipara	306.6	11.1	8.9	3.8	99	1.6	0.9	16	142	8
30. Brooxhill	288.7	10.6	10.6	6.4	96	2.1	1.1	18	166	11
31. Charbhati	211.2	12.1	11.9	6.2	88	3.1	1.2	19	188	10
32. Binakhandi	102.7	10.2	20.1	8.8	64	1.6	0.08	14	200	13
33. Maneswar	127.6	10.1	29.4	9.2	78	1.8	1.01	16	99	14

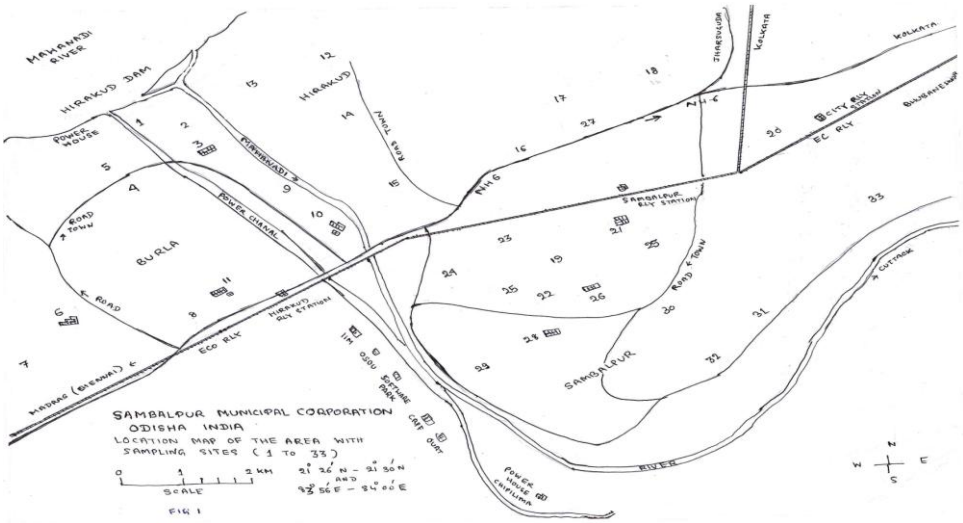

Figure 1: Sambalpur Municipal Corporation, Location map of the area with sampling sites

III. RESULTS AND DISCUSSION

The physic-chemical parameters of water samples collected from the underground water as given in the Table 1.A and Table 1.B. It is observed by pH measurement that the water samples obtained from the bore wells are slightly basic in nature, which is more than 7pH, but within the permissible limit for drinking as per WHO. But water of 6 bore wells have satisfied the permissible limit as per European standard where as TDS of water of 7 bore wells are unsuitable for drinking as prescribed by WHO. The temperature variation is found to be 30^0C to 34^0C during pre-monsoon period. These differences depend upon the rock type and depth of the wells. The hardness value of water taken from all the wells are quite less than the levels specified for drinking (limit of WHO in 500ppm) and mostly in classified as hard (Twort et al, 1974). The total alkalinity of water is high except 5 bore wells. The hardness and alkalinity of water of these bore wells are mentioned in the test probably due to the content of ground water with minerals of alkali and alkaline earth metals. Although the lower DO values, less than 4ppm indicate water pollution but usually underground water, in general is less contaminated. Except 5 bore wells, the DO levels in the rest sources are below 4ppm and it is obvious in case of ground water.

Generally ground water also exceeds the concentrations of CO_2 level less than surface water. In this study at some bore wells, the amount of CO_2 found to be very high, that is about 65ppm which exceeds the desired limit. The COD value of drinking water should not exceed 10ppm, which is

an indicator of total amount of oxidisable organic and bio-organic matters present in water. But it has been observed that in the water of all the bore wells, this parameter has exceed the limit and in some wells COD is more than ten folds of the maximum permissible limit (WHO), which is alarming. The Mg^{++} is very less in compare to Na^{+}, K^{+}, Ca^{++} in most of the cases, because these ground water are mostly associated with granite rocks. However, in some case Ca^{++} concentration is high. The amount of Chlorine in water samples is below the limit. Similarly SO_4^{2-} (sulphate) ion is less than the limiting value. The Fluoride concentration in some water samples is more than the permissible limit. As these bore wells are meant for the collection of drinking water, hence primarily the water quality has been judged from the point of view. From the present study it is found that except some bore wells when COD value and fluoride value are high, the water quality of other bore wells are good and suitable for drinking purpose.

Table 2: Variation of physico-chemical parameters with rock types.

Sl. No.	Parameter	Description	Amphibolite	Medium Grained Granodiorite	Porphyritic Granodiorite
1	pH	Potential of Hydrogen, in moles/L	7.5	7.9	7.88
2	EC	Electrical Conductivity, in µ mho /cm	1027.2	612.6	888.42
3	Temp	Temperature, in ^{O}C	32.2	33.6	33.8
4	TDS	Total Dissolved Solids, in ppm	602	302	466
5	TH	Total Hardness, in ppm	263	261	271
6	TA	Total Alkalinity, $CaCO_3$ in ppm	111	121	141
7	Ca^{2+}	Calcium, in ppm	11.30	22.4	121.6
8	Mg^{2+}	Magnesium, in ppm	7.21	6.66	8.01
9	Na^{+}	Sodium, in ppm	28.42	36.11	49.23
10	K^{+}	Potassium, in ppm	28.4	19.91	26.23
11	Cl^{-}	Chloride, in ppm	88.2	51.2	83.11
12	SO_4^{2-}	Sulphate, in ppm	5.12	2.1	2.26
13	Fe^{-}	Iron, in ppm	2.2	1.1	1.02
14	CO_3^{2-}	Carbonate, in ppm	44.6	19.2	28.60
15	HCO_3^{-}	Bicarbolate, in ppm	88.4	99.2	95.22
16	DO	Dissolved Oxygen, mg/L	3.71	3.88	3.93
17	CO_2	Free CO_2, in ppm	14.67	24.33	27.08
18	COD	Chemical Oxygen Demand, in ppm	24.11	23.11	28.61

Although the fluoride concentrations vary considerably, the samples in localities nearer to the amphibolites exposure have high fluoride contents beyond desirable level for drinking [5]. Since fluoride content in ground water commonly depends upon rock type from which they originate, the content of water, with the amphibolites and granite containing biotite, apatite, etc has resulted in higher concentration of fluoride in some areas. These minerals may also contain fluoride by replacement of hydroxide ion (OH^{-}) [6]. During weathering and circulation of water in rocks and soils, fluoride is leached out and gets dissolved in the ground water. From the study of fluoride concentration the areas around Budharaja, Ainthapali, Hirakud, village 3 Remed, Gopalpali , Burla, village 2 can be recognized as high fluoride zones(>1ppm). The sodium (Na+) absorption reaction (SAR) of 0.18 to 5.38 indicates that the ground water of the areas to be good for irrigation (U.S.D.A 1984). However sodium percentage values vary widely and except a few samples, the ground water is suitable for irrigation purpose [7].

From the lithology study these dominant rock types are amphibolites, medium granted granodiorite and porphyritic granodiorite.The variation of the physico-chemical parameters is presented in Table 2.

Petrographic analysis reveals considerable extent of alteration of the granodutites. There has been extensive sericitization of the feldspar grains. Due to weathering feldspathic rocks are also kaolinosed

with the development of clayey sand and development of aquifer conditions at shallower depths up to 15 meter.

The quality of ground water is dependent on the predominant rock types and there weathered products, the later being the host for most of the ground water in this area. The investigation involving geological, hydro-geological, hydro-chemical and statistical techniques have aided in accessing the relations of lithology with ground water quality.

The concentration of cataions and anaions of ground water of this study area is different rocks is in the following order;

a. Amphibolite:

$K^+ > Na^+ > Ca^{2+} > Mg^{2+}$
$HCO_3^- > Cl^- > CO_3^{2-} > SO_4^{2-}$

b. Medium grained granodiorite:
$Na^+ > Ca^{2+} > K^+ > Mg^{2+}$
$HCO_3^- > Cl^- > CO_3^{2-} > SO_4^{2-}$

c. Porphyritic granodiorite:
$Ca^{2+} > Na^+ > K^+ > Mg^{2+}$
$HCO_3^- > Cl^- > CO_3^{2-} > SO_4^{2-}$

The order of the above concentration for anions has a significant variation. In case of cations, except a few cases the quality of water can be generally concluded to be good for irrigation also.

IV. CONCLUSION

This is concluded from the investigation of the ground water quality with respect to physical and chemical parameters that the water is fit for drinking purposes. In some areas though concentration of fluoride is higher, still it is not harmful at present as dental fluorosis is not found in area of study.In some areas the hardness of water is high, but it is safe for drinking; only it corrodes the pipes and taps as a result they do not last long due to scale formation. The public health department should investigate the quality of water from time to time and give suggestions if needed in near future. The water is also suitable for agriculture.

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