



PRELIMINARY STUDY ON ARSENIC CONCENTRATION IN GROUNDWATER IN USUAL EXPLOITED AQUIFER IN HOCHIMINH CITY (PLEISTOCENE AQUIFER QI_m)

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ABSTRACT: Recent days, As in groundwater is a hot spot in some countries in Asia (e.g India, Bangladesh, Myanmar, Thailand) that was revealed through Executive Meetings of RAS/8/084. In Vietnam, some reports on groundwater quality in Red River Delta and Mekong Delta (with few random groundwater samples selected to analyse randomly) brought an opinion that groundwater in some region in Vietnam contains a quantity of As is over WHO Limit to As concentration in drinking water. This project had been carrying out in HoChiMinh City in order to survey and make a preliminary assesment on As content in groundwater in shallow aquifer which is uasual exploited in one of important social-economic centers of Vietnam.

1. GENERAL

HoChiMinh City take an important role in the national economic development of VietNam. According to the development progress, HoChiMinh City has to face to the rising of water supply demand due to rapidly rising population and industrial development.

Recent days, groundwater in Ho Chi Minh City region is more and more exhausted and contaminated. Thretherefore, HochiMinh City Science and Technology Office has feagure out a program on investigation the potential and pollution status of groundwater in this impotant industrial and economic region.

This project has been carrying out in frame of investigation the Arsenic concentration in groudwater bearing in shallow aquifer which is usually exploited in HoChiMinh City. Its results shall be a preliminary step for further study on Asenic and, generally, other contaminants in groundwater in NamBo plain.

2. HYDROGEOLOGICAL CHARACTERS OF CONCERNED AQUIFER (QI_m)

This is an usual exploited aquifer in study region by its high potential and quality. As same two Neogene aquifers, water quality gradually worse from the North to South. Another character of this aquifer is that, from North to South, there are no effect aquitard between water bearing layers. So, along this direction, groundwater has a character of that in alluvium-marine deposit and that is causion of groudwater quality to be down from CuChi, HocMon to BinhChanh, NhaBe. Its thickness varies from 10m to more than 50m.

3. SAMPLING NETWORK AND IN-SITU WORK

The sampling network is set up to gather entirely delegate QI_m groundwater in study region. Sampling points distribute on allmost area of the city except NhaBe and CanGio Districts because of lacking for borehole in the concerned aquifer.

The sampling network is concentrated into the vicinity of 1g/l TDS frontier that stretches from North BinhChanh, TanBinh, GoVap to ThuDuc and District 9.

Before sampling, we pump out the residual water in the case until pH, TDS becomes stable. It is to be sure that sample was taken up from the aquifer. The samples for Cation and As analysis are acidized by appropriate concentration of HCl that make samples has a appropriate pH.

Other parameters as TDS, temperature, conductivity, salinity of water were also measured in the field. Finally, all samples were surely confined and sent to laboratories.

4. ARSENIC ANALYSIS

As concentration in water is precipitated with PbS in Thioacetamide. Afterwards, the precipitation is filtered through 0.4µm paper filter and then activated by $2.5E12 \text{ nCm}^2.S^{-1}$ in DaLat Reactor (DaLat Nuclear Research Institute) in 6 hours. The Arsenic concentration is determined by analysing its Gamma spectrum on gamma spectrometer with HPGe detector.

5. RESULTS

Based on the analysis results (see table1), preliminary we may partition this aquifer in HoChiMinh into 3 zones:

- **Zone 1:** The Eastern side of HoChiMinh City-occupied parts of LongPhuoc (District 9), AnPhuDong (GoVap district) and ThanhLoc (District 12): Groundwater in this zone is acidic, high Fe content with not so low pH and As content in this zone is relative high (from 4-5ppb to higher than 10ppb)
- **Zone 2:** perched on West-SouthWest side of HCM City: Groundwater in this zone is lightly salty, high Fe content, low pH (from 4.5-5.2) and As content is not so high. The mean value is only few ppb (the highest found out onto sample As26 is 6ppb).
- **Zone 3:** the rest of sampling area. In this zone, As content is much less than WHO limit. Most of them are less than 1ppb.

The result are also provided that high As content occurred in acidic water zone with high Fe concentration and reducing condition. However, in some boreholes, groundwater with not so high Fe content but contains a notable As concentration over the WHO Limit.

Other noticeable thing is the deposit conditions of those zones are differently. QI_{III} aquifer in zone 1 is formed with alluvium-marine sediments with much of organic humus. It makes the geo-chemistry environment becomes reducing. That is a favourable condition for As leakage into water. Meanwhile, in zone 2, the aquifer is formed from coastal and a estuarial sediment. In that condition, As compounds are relative immobile and the As content in groundwater not so high. In Zone 3, Pleistocene aquifer formed from alluvium sediment. Groundwater is classified in very good quality with low TDS and As content therefore is very low.

Another interest is when correlate As content with other concentration, we also see that groundwater with high HCO_3^- has high As concentration and groundwater with high SO_4^{2-} has low As concentration.

6. CONCLUSION

Generally, As content in groundwater in Pleistocene aquifer in HoChiMinh City is not so high, except some region it is over the WHO Limit to As content in drinking water. (the highest As concentration in groundwater detected in study region only reached up 21.9ppb at a borehole in District.9, HCM City. In that zone, water is bearing in alluvium-marine sediment layer that contains lot of organic humus, high Fe, low pH and classified into HCO_3^- type.

In the West-South West of the City, the aquifer has same characters with above zone but groundwater inhere in Cl-SO_4^{2-} and As concentration is not high (only 4-5ppb). The rest zone, with the largest area of HoChiMinh City, As concentration in groundwater is lowest (less than 1ppb).

However, this is just a preliminary result from an investigation with not much samples gathered in the limit area of HoChiMinh City. Therefore, this result just brought out a general view on the presence of As content in groundwater in an aquifer which is usually exploited in study region and confirmed the reliability of analysis As content in water by means of neutron activation. To gain more profound result on this topic as well as to protect this important water resource more effectively, we do have to pursue a large scale project to determine the occurrence mechanism, assess and predict the transmissibility of this toxic agent

The actual meaning of this project results is if in study region occurred high As concentration in groundwater, it would have others toxic agents that hazard to people health.

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Table 1: Results of analysis

KH M	CORD. X	CORD. Y	DEPT H	To	pH	Cond	As	Fe _{tc}	Sal	TDS	Ca	Mg	Na	K	Cl ⁻	CO ₂	HCO ₃ ⁻	CO ₃ ²⁻	SO ₄ ²⁻	NO ₃ ⁻
As01	658801	1233584	0	28.7	6.70	272	0.29	6.88	0	26	1.40	0.48	1.81	1.19	7.62	30.20	19.60			2.62
AS02	659920	1232516	32	28.8	6.50	42	0.03	3.7	0	18	0.44	0.21	0.88	0.18	6.52	13.55	3.66			2.01
As03	660054	1231008	36	28.2	6.50	51	0.46	4.19	0	28	1.64	0.58	2.15	1.65	7.03	32.50	18.80			2.33
As04	658582	1230428	30	28.7	6.40	37	0.08	3.8	0	26	1.63	0.56	1.87	1.77	7.13	30.20	18.60			2.77
As05	661805	1230774	20	28.8	6.40	34	0.13	7.52	0	27	1.62	0.52	1.81	1.94	7.26	31.11	19.36			2.36
As06	663886	1229763	30	28.4	6.20	116	5.91	5.59	0	189	0.49	0.68	10.92	0.93	31.2	16.4	60.1		2.06	
AS07	668370	1210025	35	29.6	5.50	34.7	0.45	3.12	0	27	1.60	0.54	1.95	1.95	7.29	30.80	19.20			2.40
As08	663541	1214861	22	29.8	4.91	22.3	0.04	2.6	0	17	0.40	0.18	0.81	0.19	6.62	13.20	3.60			1.82
As09	663713	1207794	52	29.5	6.20	231	6.16	16.56	0	184	0.4	0.71	10.9	0.98	33.3	16.6	59.5		2.07	16.00
As10	675790	1205152	41	29.7	5.57	30.3	0.09	6.77	0	24	0.40	0.18	1.21	0.59	7.02	35.20	4.56			1.97
As11	678078	1200725	37	29.0	4.94	109	0.01	4.25	0	85	3.20	1.43	18.86	4.58	40.61	79.20	11.28		7.56	6.57
As12	672153	1200930	28	29.6	4.93	23.4	0.04	3.81	0	18	0.20	0.29	1.03	0.68	5.69	44.00	2.64			2.81
As13	666683	1202422	26	29.1	6.16	2550	0.11	6.41	1.1	1941	8.00	39.3	322	19.5	727.37	57.20	58.57		24.55	3.53
As14	668507	1202115	29	28.4	5.60	717	1.68	25.01	0	567	6.00	16.9	71.3	15.6	131.83	17.60	217.00		3.29	3.91
As15	662965	1194373	28	28.6	4.30	3630	0.11	17.42	1.8	OFL	144.00	171	494	39	1663.43	35.20	0.00		106.44	
As16	670091	1190791	30	29.0	5.60	2430	0.52	12.29	1.1	1991	16.00	66.1	256	26.3	687.22	57.20	23.76		62.45	1.10
As17	669769	1191539	50	29.6	4.59	3070	0.06	7.22	1.4	OFL	26.00	107	448	58.5	951.01	127.60	3.36		135.06	

KH M	CORD._ X	CORD._ Y	DEPT H	To	pH	Cond	As	Fe_tc	Sal	TDS	Ca	Mg	Na	K	Cl	CO ₂	HCO ₃ ⁻	CO ₃ ²⁻	SO ₄ ²⁻	NO ₃ ⁻
As52	698622	1199741	32	28.6	4.00	68.4	0.13	3.76	0	51	0.11	0.51	2.02	0.18	5.4		0			15.90
As53	702081	1195460	38	29.1	6.41	1877	0.02	13.43	0	1362	2.80	7.39	380	14.2	482		239		99.70	9.70
As54	701502	1195794	40	28.4	6.27	3220	20.00	22.57	1	OFL	5.42	18.50	679	15.4	802		502		4.30	40.40
As55	694300	1193100	48	28.8	4.73	119.2	0.02	10.060	0	849	0.33	0.52	17.9	4.42	15.6		8.41		52.00	16.00
As56	700059	1194810	40	28.9	7.57	1080	0.01	14.780	0	678	11.80	4.29	234	3.42	34.8					1.20
As57	703269	1194116	50	29	6.16	1700	0.14	17.260	0.7	1408	0.2	0.25	31.6	3.9	13.4	72.6	121.9		15.50	
As58	704050	1193784	30	29.5	6.16	2920	21.90	18.620	1.3	OFL	5.2	17.5	318	13.4	619	72.6	421.9		4.50	44.10
As59	703816	1195862	24	28.9	6.41	1877	3.27	3.43	0	1154	2.56	7.39	352	14.1	282		225		89.70	9.10
As60	703681	1198173	28	28.8	6.87	1047	4.68	5.630	0	687	11.70	4.29	124	3.42	358		125		2.80	1.40
AS61	674720	1210581	31	28.3	6.40	34.9	0.09	4.57	0	17	0.42	0.19	0.8	0.2	6.61	13.25	3.61			1.82
As62	674720	1204340	40	29.6	6.30	37.8	0.13	5.93	0	25	1.77	0.49	1.75	2.01	6.61	23.97	19.61			2.52
As63	703795	1198175	0	28.4	6.30	213	4.84	8.85	0	175	0.41	0.75	10.16	0.95	32.7	16.0	59.7		2.00	16.10
As64	653186	1214764	28	28.4	7.25	231	0.05	4.11	0	154	0.4	0.71	10.8	0.98	5.30	32.4	1.6			
As65	657358	1219726	30	28.3	6.60	211	0.02	2.83	0	163	0.52	0.6	14.1	1.16	3.2	11.9	2.8			
As66	663641	1224267	32	28.8	6.50	42	0.05	3.7	0	18	0.44	0.21	0.88	0.18	6.52	13.55	3.66			
As67	670811	1220693	28	29.7	6.10	41.3	0.81	4.55	0	68	1.8	1.6	4.8	4.71	2.5	67.0	3.7		1.80	1.20
As68	672788	1214756	25	28.4	6.20	116	0.42	2.59	0	189	0.49	0.68	10.92	0.93	31.2	16.4	60.1		2.06	

KH M	CORD. X	CORD. Y	DEPT H	To	pH	Cond	As	Fe_tc	Sal	TDS	Ca	Mg	Na	K	Cl ⁻	CO ₂	HCO ₃ ⁻	CO ₃ ²⁻	SO ₄ ²⁻	NO ₃ ⁻
			(m)			(mS/cm)	(ppb)	(ppm)	(g/l)	(mg/l)	(mg/l)									
As18	669975	1193054	30	30.1	5.21	227	0.61	6.31	0	174	1.40	5.71	19.8	7.21	58.04	44.00	0.00		8.18	1.49
As19	672918	1189697	50	29.1	5.31	15180	0.07	8.27	8.4	OFL	380.00	661	1621	97.5	5492.67	184.80	50.17		614.95	
As20	674176	1189433	30	29.4	4.66	671	0.41	11.22	0	524	16.00	76.8	32.2	11.7	99.81	83.60			117.92	
As21	683581	1186171	50	30.0	6.87	12720	0.11	13.68	6.8	OFL	130.00	428	1909	87.8	4719.15	215.60	319.25		244.79	
As22	672928	1195571	36	29.8	6.20	36.5	0.13	6.28	0	26	1.60	0.52	1.95	1.85	7.19	30.10	19.25			2.22
As23	671608	1194756	26	29.7	6.10	41.3	0.22	6.55	0	68	1.8	1.6	4.8	4.9	24.7	67.0	8.8		1.80	6.10
AS41	693830	1202105	10	29.8	5.74	138.3	0.12	3.45	0	106	13.60	2.86	3.8	2.73	12.80	26.40	33.37		36.16	2.52
As42	682754	1195323	40	30.5	5.09	76.7	0.03	3.59	0	59	1.20	1.00	6.56	0.59	19.00	70.40	8.16			13.67
As43	695650	1189834	24	29.5	4.43	8120	0.22	10.87	4.1	OFL	80.00	285	931	39	2251.09	294.80			686.00	
As44	695693	1190424	30	29.5	5.02	5200	0.03	8.61	2.5	OFL	35.00	150	540	19.5	1400.91	136.40	3.36		110.20	
As45	694289	1191067	56	28.9	3.76	2430	0.04	7.27	1.1	1913	14.00	66.1	247	20.5	607.52	88.00			138.55	
As46	693313	1191664	35	28.8	4.44	334	0.15	8.24	0	263	4.00	3.57	27.6	9.56	63.68	92.40	3.84		24.44	31.61
As47	700238	1195613	36	28.8	4.35	1619	0.27	5.79	0.6	1261	6.00	7.14	174	13.7	354.53	193.60			87.38	
As48	698425	1195726	35	28.2	4.29	162.9	0.01	6.35	0	129	0.60	2.43	14.5	4.9	27.95	52.80			27.93	1.80
As49	700031	1197208	40	28.7	4.86	342	0.05	6.67	0	269	3.60	6.78	34.5	5.66	77.10	127.60	37.45		11.58	0.52
As50	695107	1193083	35	28.8	4.72	1032	0.14	14.22	0	677	3.51	6.44	156	13.4	284		0		40.90	1.10
AS51	700625	1195082	36	28.4	6.02	1485	0.11	11.64	0	845	7.98	20.00	237	17.2	785		0		8.20	1.40