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Mine-Pit Pond Hydrogeochemistry based on Water Quality with respect to Different Seasons

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Abstract

Water resources mainly formed nature itself and man-made activities.Ponds are mainly of three general classes, of which one group is those whose basins are the results of man's activities such as excavation,quarrying and mining. Some of these water filled pits are among the most attractive water bodies,because they contain very clear water. The ponds formed by the mining activities may be referred to mine-pit ponds are mainly rain fed. Ecological information on such ponds is totally lacking anywhere from the world.In the present study,the hydrogeochemistry of such ponds were analyzed and revealed that,the water in these ponds were unpolluted ,clean and that can be utilized for the routine water needs.The parameters analyzed were characterised by temperature as same as atmospheric temperature , acidic pH,high DO and low CO2,alkalinity,hardness and nutrients.There was no significant difference between the surface and bottom water. The hydrography of the clay-pit pond is not much different from that of small, freshwater, lentic systems. Investigation into the chemistry of the clay deposits in which these ponds are excavated, is likely to throw more light as their ecology.

Key words: Hydrogeo chemistry , minepit,transparency, lentic

Introduction

The lentic systems of peninsular India are unique, as most of them are man-made unlike in the temperate and sub-temperate zones. Further, they are much smaller and hence their ecology is greatly influenced by the local climatic conditions. Among these different types of lentic water bodies, ponds occupy very significant position in the life of man and animals. Ponds are very small, shallow bodies of standing water in which relatively quite water, extensive plant occupancy and inhabitation of numerous animals (Welch, 1952). The depth of the pond is rarely morethan 2m.The source of water supply to the pond may be from a river or from a spring or rain water. The surface area of ponds covers about 3% of India's land area (Pisharoty, 1985)

Ponds are mainly of three general classes, of which one group is those whose basins are the results of man's activities such as excavation,quarrying and mining. There many kinds of excavations done by man, for theremoval of gravel, limestone,coal or other near surface- mineral deposits; the pits later become filled with groundwater or rain water.Some of these water filled pits are among the most attractive water bodies,because they contain very clear water.The different kinds of excavated ponds according to Bennet(1971) are gravel-pit ponds,strip mine pondsphosphate pits,quarry ponds and borrow pits.Ponds formed consequent on mining of clay for industrial purposes may be referred to as clay pit ponds.

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These ponds are mainly rain fed. In spite of the near uniquenessof these water bodies, some of which are some are long lived for 9-12 months, there is practically no information on the ecobiology of minepit ponds. Hence the present study.The ponds formed consequent on mining of clay of industrial purposes may be referred to minepit ponds. These ponds are mainly rain fed. Ecological information on such ponds is totally lacking anywhere from the world. The fresh and apparently unpolluted water in the minepit pond was calm and clear.

Materials and Methods

The study area lies between $8^0$35′ and $8^0$40′N lat. And $76^0$50′ and $76^0$55′ E long. At Karamoodu, this is a small junction about 2km east of Mangalapuram, about 27 km northeast of Trivandrum city, on the Mangalapuram-Pothencode road. The main objective of the present study was to analyse the limnological features of the minepit pond; the results of the analyses of the hydrography are reported here. The Study was conducted in the period of seven months in the year May 2010 to November, 2010 All the collection was done in the early morning hours between 8 and 9 a.m. during the pre-monsoon,,monsoon and post-monsoon seasons.Hydrographical parameters analyzedare temperature, pH, dissolved oxygen, dissolvedcarbondioxide, total alkalinity, total hardness, transparency and the nutrients (phosphate, silicate, nitrite, nitrate and sulphate) of the surface and bottom waters. The analyses were carried out employing standard procedures.

Surface water samples were collected using a clean polythene bucket and the bottom water samples, using Van-Dorn bottom water sampler. Atmospheric water and sediment temperatures were recorded at the site itself using a Celsius thermometer of +/- 0.5C accuracy.

Transparency was measured using secchi disc and the values were expressed in centimeter. A portable pH meter of +/- 0.1 accuracy was used to measure the pH. DO was measured by the classical Winkler's method. CO_2, alkalinity and hardness were measured by the following the standard method of APHA (1998) and the results were expressed in mg/L

The water samples for nutrient analysis collected in meticulously clean polythene bottles, after rinsing each with the pond water, were preserved with a few drops of chloroform and brought to the laboratory. Phosphate was estimated by the method of Murphey and Riley (1962), silicate by the method of Koroleff(1983), nitrite by the method of Morris and Riley(1963), and sulphate by the method of APHA(1998). The absorbance of the appropriated treated water samples was read in UV-VIS double beam spectrophotometer calibrated using five standard concentration of each radical. The values of phosphate, nitrite, and nitrate were expressed in µg/L, of silicates in µg/mL and sulphate in mg/L.

Results and Discussion

The results of the hydrographical parameters analyzed are temperature, pH, dissolved oxygen, dissolved carbondioxide, total alkalinity, total hardness, transparency and the nutrients (phosphate, silicate, nitrite, nitrate and sulphate) of the surface and bottom waters. are presented in Table 2.1and figures 2.2-2.1

Temperature

Parameters Period (2010-May-2011Nov)

Data of temperature measurements are given in Tables 2.1 and in Figure.2.2.Seasonal variations during pre-monsoon (May), Monsoon (Aug) and Post-monsoon (Nov) in atmospheric temperature and water temperature on surface and bottomwere noticed. The maximum atmospheric temperature was found in the pre-monsoon (32°C) and minimum atmospheric temperature was noticed (26°C) in the monsoon.The surface and bottom water temperatures were observed in 31°C during pre-monsoon, 29°C & 27°C in monsoon and 27°C & 28°C was observed in the post- monsoon period. The mean surface water temperature (29.0^{0}C) was marginally higher than the mean bottom water temperature (28.6^{0}C).

pH

The hydrogen ion concentration of the water fluctuated within a narrowrange, in the pond. Water was acidic almost throughout the period of study.The lowest pH 4.5 was noted in Aug 2010,in the monsoon season for both surface and bottom water and registered an apparent tendency to increase in post-monsoon in the month of Nov 2010 (5.8 & 5.9) to reach the near neutralityand then to 5.5 & 6.6 on pre-monsoon period. The Results of mean comparing surface and bottom

Table.2.1.Hydrographical parameters analysed during the period of May 2010 to November, 2010

Parameters	Period (2010-May-2011Nov)				Mean
	Pre- monsoon May		Monsoon Aug	Post-monsoon Nov	
	Atm	32	26	29	
Temp (^{0}C)	**S***	31	29	27	29.0
	B*	31	27	28	28.6
pH	**S**	5.5	4.5	5.8	5.3
	B	6.6	4.5	5.9	5.7
DO (mg/l)	**S**	9.3	9.3	2.4	7.0
	B	7.5	9.3	2.8	6.5
CO_2 (mg/l)	**S**	3.3	1.1	11.0	8.4
	B	2.2	2.2	11.0	5.1
Alkalinity (mg/l)	**S**	5.0	10.0	5.0	6.7
	B	7.5	15.0	7.5	10.0
Hardness (mg/l)	**S**	9.0	12.0	26.0	15.7
	B	14.0	20.0	22.0	18.7
Transparency (cm)		186.0	99.5	89.0	124.8
Depth (cm)		186.0	185.0	150.0	173.7
Phosphate (µg/l)	**S**	6.2	8.7	0.3	5.1
	B	6.3	5.6	**ND***	4.0
Nitrite (µg/l)	**S**	2.5	1.5	0.6	1.5
	B	0.2	1.8	3.3	1.8
Nitrate (µg/l)	**S**	**ND**	36.0	42.0	26.0
	B	**ND**	35.5	14.6	16.7
Silicate (µg/l)	**S**	5.2	18.5	5.3	9.6
	B	4.4	16.1	5.9	8.8
Sulphate (mg/l)	S	2.4	1.6	5.0	3.0
	B	0.5	0.1	2.5	1.1

water pH revealed that no significant difference could beobserved between seasons (Table 2.1. & Fig 2.3). It can therefore be concluded that seasons are almost similar with respect to surface and

bottom water hydrogen ion concentration.

S*- Surface,B*-Bottom, ND*- Not Detected

Dissolved Oxygen

Dissolved oxygen content of the water is an important gauge of existingwater quality and the ability of water body to support aquatic life.DO contents of surface and bottom waters did not show much difference except in post-monsoon; the mean DO was 7.0 mg/L for surface water and 6.5mg/L for bottom water.DO was above 7.0mg/Lof both water on pre-monsoon (9.3mg/L &7.5mg/L) and monsoon (9.3mg/L) inMay and August. But in the period of post- monsoon of it was low as 2.4 and 2.8 mg/L,respectively for surface and bottom water(Table 2.1.&Fig 2.4).The pattern of seasonal variation in DO for surface and bottom water were more or less similar as considered by the mean variation..

Dissolved Carbondioxide

Results of mean comparing the dissolvedcarbondioxide in the surfaceand bottom water revealed a significant difference were observed (Table 2.1 &Fig 2.5).Dissolved CO_2 content was varied between 1.1 mg/L and 11.0mg/Lin both surface and bottom waters.In the pre-monsoon period it is observed as 3.3 mg/l& 2.2 mg/l,in monsoon period as 1.1 mg/l&2.2mg/l and very high in the post-monsoon as same on both surface and bottom water was 11.0mg/l. It can therefore be concluded that seasons are almost varied with respect to the dissolved carbondioxide content in the surface and bottom water.

Alkalinity

The mean alkalinity of both surface and bottom water between 6.7 mg/L to 10.0 mg/L. Though alkalinity of both surface and bottom waters registered comparatively wide seasonal fluctuations during the study period (Table 2.1 &Fig 2.6).The alkalinity of monsoon season (10.0mg/l &15mg/l) was drastic increase than pre-monsoon (5.0mg/l &7.5 mg/l) and post- monsoon (5.0mg/l &7.5 mg/l).It is concluded that during monsoon salt concentrations were normally increased both surface and bottom water..

Hardness

For surface water, total hardness ranged 26.0mg/l - 9.0mg/L and for bottom water, 14.0mg/l-22.0mg/L. The mean hardness were observed as 15.7 mg/l on surface water and 18.7mg/l on bottom water.The variation of hardness among both water were observed as 9.0mg/l &14.0mg/l,12.0mg/l&20.0mg/l and 26.0mg/l & 22.0mg/l respectively on all seasons of the study period (Table 2.1 &Fig 2.7).Hardness of bottom water is generally higher than the surface water except in November,the post-monsoon period. For bottom water hardness registered an increasing trend from pre-monsoon to post-monsoon,this was an almost same trend registered by alkalinity of both water.

Transparency and Depth

Light penetration depends partly on the light flux but mainly on the opticalproperties of water. Light penetration depth or transparency is influenced by suspended materials and plankton.During pre-monsoon the water was fully transparent, the bottom being clearly visible.Both the transparency and depth were same (186.0cm and 186cm). During the the monsoon and post-monsoon periodtransparency of water became99.0cm and 89.0cm and depth of the pond varied from 185.0cm to 185 cm respectively.The mean variations of both were observed as 124.8cm and 173.7cm (Table 2.1 &Fig 2.8).It revealed that during dry season the transparency and depth was high.

Phosphate

The maximum phosphate content in surface water (8.7μg/l) were observed in the monsoon period and it in the bottom water on pre-monsoon (6.3μg/l) period (Table 2.1 & Fig 2.9).The mean variation of phosphate content in both waters were observed as 5.1 μg/l and 4.0 μg/l respectively .In the pre-monsoon the phosphate content was with a slight difference on both surface and bottom water6.2 μg/l 6.3 μg/l,in monsoon period ,it was 8.7 μg/l and 5.6 μg/l.But in the post-monsoon season only the surface water with minute amount of phosphate content(0.3μg/l) and bottom waterwill not detected**(ND).**

Nitrite

Results of mean variation comparing the nitrite content of the surfaceand bottom water1.5 μg/l and 1.8 μg/l revealed no significant difference between seasons on the study period (Table 2.1 & Fig 2.10).In the pre-monsoon thenitrite content were observed as 2.5 μg/l and 0.2 μg/l on surface and bottom waters, in monsoon season it was 1.5 μg/l and 1.8 μg/l and in the case of post-monsoon period it was observed as 0.6 μg/l and 3.3 μg/l .

Nitrate

Nitrate is the highestoxidized form of nitrogen. Higher concentrations ofnitrate enter into the water resources increase the growth of nuisance algae and trigger eutrophication.By comparing the nitrate concentration of thesurface and bottom water of all seasons revealed that no significant difference could be observed in the monsoon period 36 μg/l and 35.5 μg/l and in the pre-monsoon nitrate content were not detectedon both surface and bottom water **(ND)**.But there is a dramatic changes were observed in the post-monsoon season as 42.0 μg/l and 14.6 μg/l (Table 2.1 & Fig 2.11) respectively. Here the mean variation indicated that, there is a significant difference on both surface and bottom water was expressed as 26.0 μg/l and 16.7 μg/l.

Silicate

Silicate concentration is very important in the regulation of growth ofdiatoms in fresh water. The mean variation of silicate content in both surface and bottom water were observed as slight difference with 9.6 µg/l and 8.8 µg/l.But as comparing the seasonal fluctuations it was indicated thata dramatic change were showed in the monsoon period 18.5 µg/l and 16.1 µg/l .But in the case of pre-monsoon 5.2 µg/l and 4.4 µg/land post-monsoon 5.3 µg/l and 5.9 µg/l respectively (Table 2.1 & Fig 2.12).It is concluded that, during wet season the highest value of silicate content in surface and bottom water was observed and during dry season value of silicate content in bottom water was observed in minimum.

Sulphate

The mean variation of silicate content in both surface and bottom water were observed as significant difference with 3.0 µg/l and 1.1 µg/l.But as comparing the seasonal fluctuations it was observedas in thepre- monsoon period 2.4 µg/l and 0.5 µg/l , in the case of monsoon 1.6 µg/l and 0.1 µg/land post-monsoon 5.0 µg/l and 2.5 µg/l respectively (Table 2.1 & Fig 2.13). It is concluded that, there is no remarkable variations on all seasons.

Comparison of the mean variation of all hydrographic factors in surface and bottom waters showed thatmarginally higher in surface water than the bottom water except in the case of pH and alkalinity. But the mean nitrate content in both surface and bottom water noticeably higher.

Fig 2.2-2.13: Seasonal variations of hydrographic parameters

Fig 2.2- Temperature

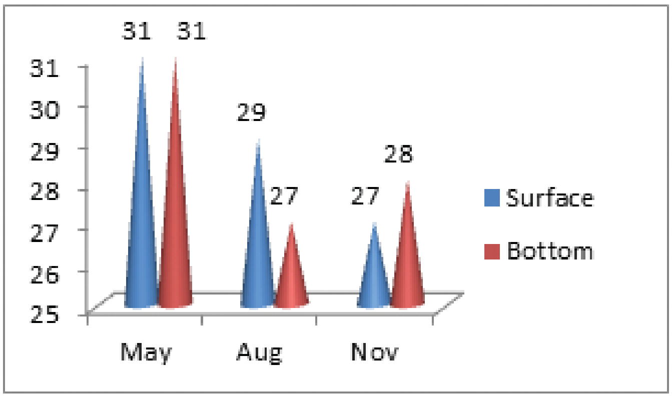


Fig 2.3- pH

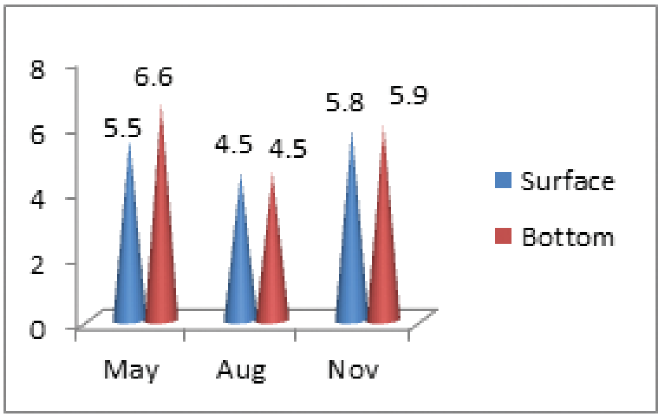


Fig 2.4 - DO

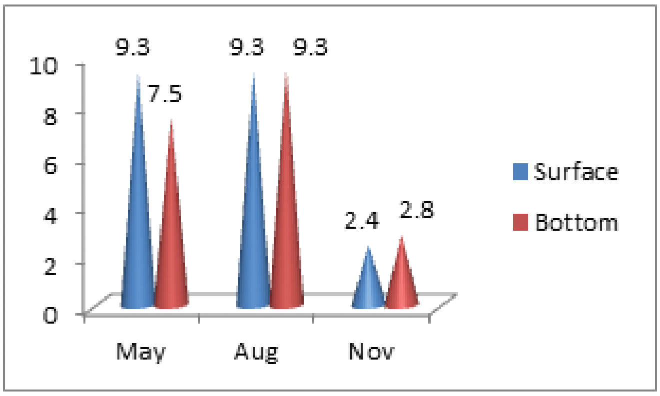


Fig 2.5- CO_2

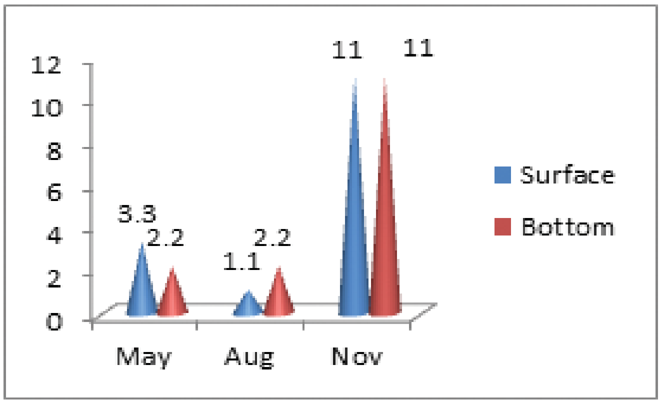


Fig 2.6- Alkalinity

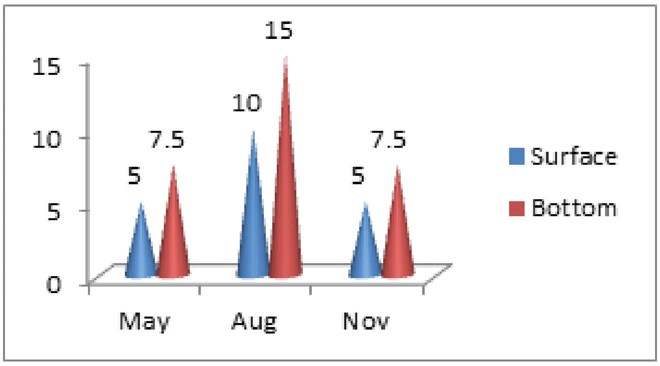


Fig 2.7- Hardness

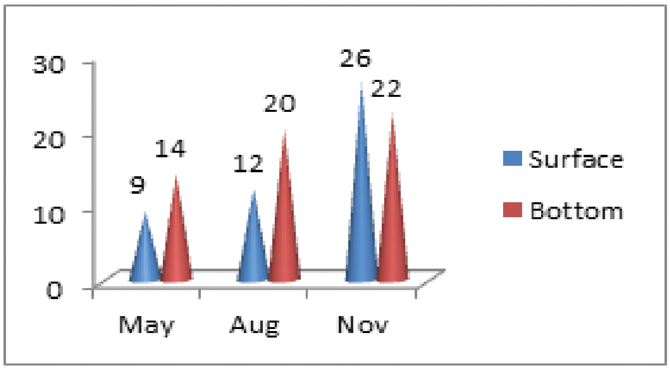


Fig 2.8- Transparancy& Depth

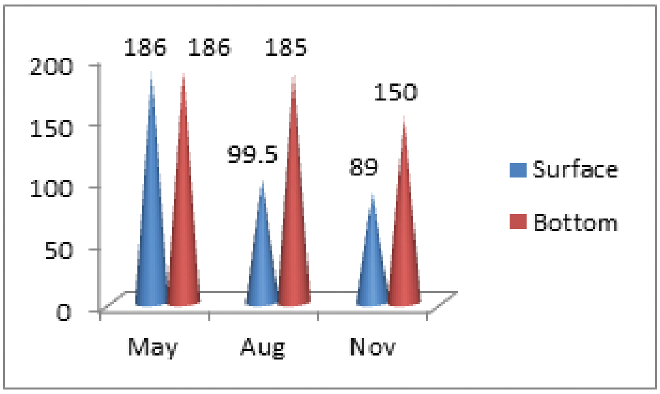


Fig 2.9- Phosphate

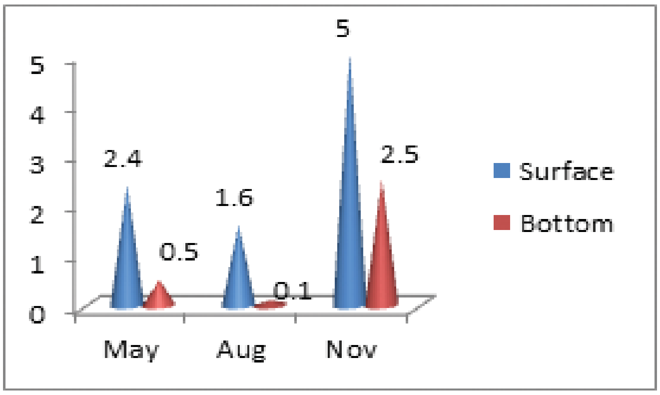


Fig 2.10- Nitrite

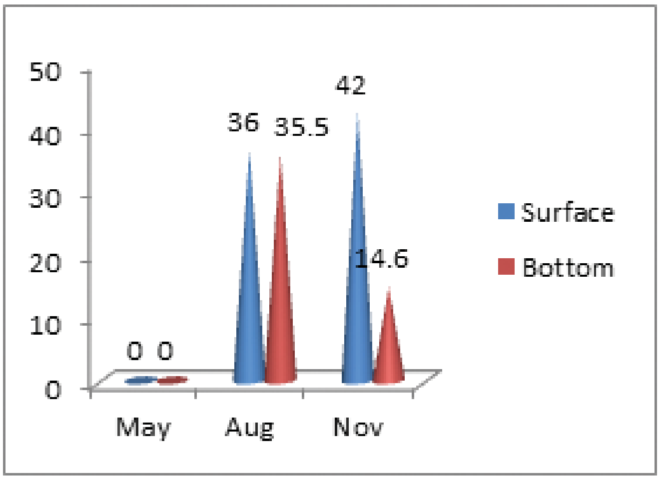


Fig 2.11- Nitrate

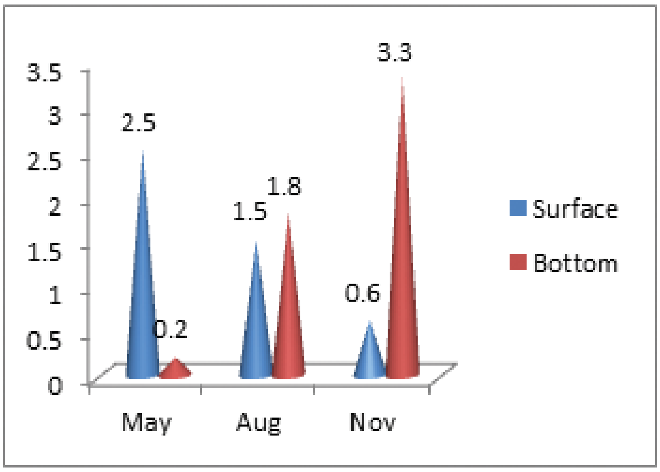


Fig 2.12- Silicate

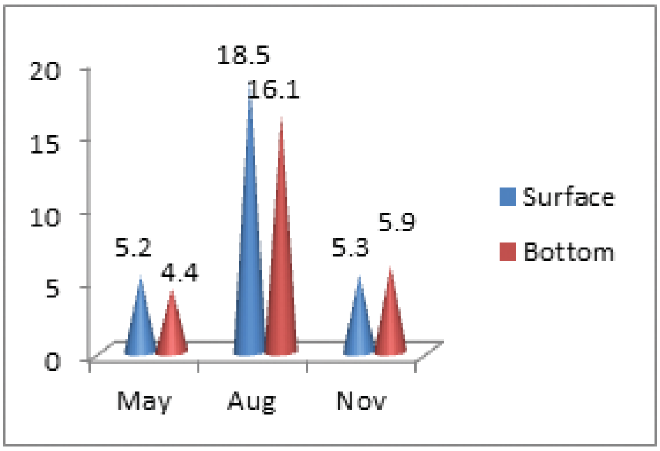
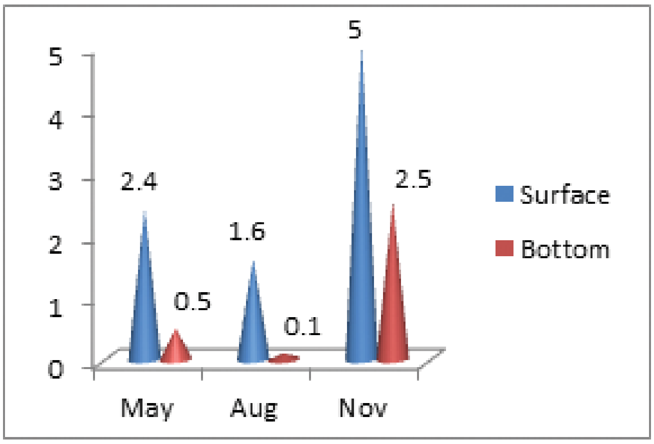


Fig 2.13- Sulphate



Studies by Zingde(1981), Hegde et al.,(1984) and Angadi *et al.*(2005) revealed considerable difference between air and water temperature in freshwater lentic systems. They suggested that the relation between atmospheric and water temperature of the minepit pond and the atmospheric temperature of the region was not highly pronounced.According to King, Varkey John, Olsen and Sommerfeld and Goel et al, High pH in the normally associated with high photosynthetic activity in water. In the clay pit pond, not only was the pH on the acidic side for most part of the community of the minepit pond was very lean both in number and in species diversity and submerged vegetation was nearly lacking in the pond during most part of the study period.

DO concentration in Indian inland waters is reported to be highly variable in space and time and among the water bodies. In small water bodies such as ponds and tanks, the variation in DO is more pronounced. The DO content of the minepit pond was reasonably high, and had a wide range but a much a lower minimum value than the reported for the small fresh water lentic system in tropics.In the Jagattank, Gulbarga, DO register decreasing trend during summer months. Similar results were reported for the small other fresh water ponds by Subbama and Rama, Subha and Shastree Anjana and Kanharekumar, Rao and Mahmood and Kaur *et al.*, In contrast in the present study the DO was higher during summer months than the colder post- monsoon months. The fitness of aquatic ecosystem is to a considerable extent, decided by the amount of free CO_2 buffers the environment against rapid shifts in acidity and alkalinity and regulates biological processes in aquatic communities.In the minepit pond free CO_2 was present throughout the period of study, yet the phytoplankton biomass generally very low. The present results thus attest the contention of Cole and suggest that factors other than free CO_2 are involved in the regulation of phytoplankton biomass in water bodies unlike held by Sreenivasan, Kaushik and Saksena.

In natural waters in the tropics alkalinity varies widely with space and time nature of the bottom deposits, plankton and anthropogenic interference such as detergent input into the water body. The reported range of alkalinity of Indian water is from about 40 to <1,000 mg/L. According to Moyle water bodies with alkalinity > 200 mg/L must be reckoned as highly productive and according to Alikunhi the alkalinity of highly productive water ought to be >100 mg/L. In the mine pit pond alkalinity was very low the highest concentration recorded during the period of study was only 25 mg/L obviously indicating the cleanliness of its water

The hardness was higher than alkalinity indicating that hardness of this pond is of the permanent type as suggested by kaushik and saksena(1999).Sawyer(1960) classified fresh water into three groups based on hardness,(i)soft(hardness=0-75.0mg l^{-1}),(ii)moderately hard(hardness=75.0-150.0mg l^{-1})and (iii)hard(hardness= 150.0-300.0mg l^{-1}).On this scale, the minepit pond belongs to the first category.

All natural waters are turbid, and the transparency of inland waters of India shows great temporal fluctuation (Kaushik and Saksena, 1999).from visual observations. The turbidity of the pond indicated the presence of all the three classes of substances namely clay, silt and colloidal particles, but certainly not to the extent to cause high turbidity. In fact during some months, the water in the pond was fully transparent, the bottom being clearly visible. It is interesting in this context that in the mine –pit pond, even though the secchi disc values varied during the study period of observation, comparing the values with the actual depth of water in the pond. Even though the abundance of phytoplankton varied irregularly during the period of study (Shijimol, 2005), this is did not appear to have had any effect on the transparency of water in the mine pit pond.

In the mine –pit pond Phosphate content was very low compared to that reported by Vijayakumar and paul (1994), Anjana and kanhare (1995), Kumar(1995),Rao and Mahmoodu (1995), Angadi et al(1999)and Paul and Varma (1999).This probably is because the pond is not aged. The absence of pollution of any kind might also have kept the phosphate content low in this pond. However, as reported for many small fresh water ponds/ tanks, in the minepit pond phosphate content was higher during monsoon and post monsoon months, suggesting that rain water /seepage water brings in phosphate into the pond during this period. In the mine –pit pond silicate content was somewhat similar to that for some ponds in Gwalior reported by Kaushik and Saksena (1999)but showed a wider range and higher maximum than that reported for jagat tank by Paul and Varma (1999).

In the minepit pond Nitrite content was much lower than that reported for freshwater taks/ponds in the tropical region. In comparison,in the minepit pond the Nitrite content,the observation is in agreement with that by Ayyappan and Guptha (1981)and Paul and Varma (1999).The sulphate content of the minepit pond was somewhat in agreement with those reported by Hutchinson (1957).

The Nutrient contents of the minepit pond have been very low compared to that in other tropical lentic ecosystems. This might be because of the fact that unlike in other freshwater systems where inputs of these inorganics come from various sources, in the minepit pond the contents of these chemical are primarily dependent on the amounts resident in the clay deposits.

To sum up, in general, the hydrography of the minepit pond is not much different from that of small, freshwater, lentic systems of the country and of the tropical region. Some features such as the dissolved oxygen and carbon dioxide regimes and the nutrient dynamics of the small, comparatively long lived temporary, totally unpolluted (at least by organicpollutants) minepit pond do not quite tally with that of other small, freshwater, lentic systems .Investigation into the chemistry of the clay deposits in which these ponds are excavated, is likely to throw more light as their ecology.

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