

8. Water column physical and chemical parameters

Water samples were taken at stations 1, 8, 9 and 15. Samples were taken from the surface (0-3m) and 100m at stations 9 and 15, the surface (0-3m) and 50m at station 1 and the surface (0-3m), 50m and 100m at station 8.

Vertical stratification was measured using a submersible CTD sensor. Temperature was measured as the CTD sensor was lowered (downcast) and as it was retrieved (upcast).

Water sampling was conducted using a 12-litre Niskin water sampler. Samples were stored in appropriate containers and conditions for the range of analyses. Some analyses were carried out on deck, while more detailed chemical analyses were carried out at AmC's laboratory following methods described in Appendix 2.

The 2010 Chirag water analysis data will be compared to the results from 2008 Chirag Survey.

8.1. Vertical Stratification

Figure 8.1 shows the temperature/depth profile and indicates the degree of vertical stratification of the water column on the day when samples were taken.

The water column in the survey area was strongly stratified, there was a temperature difference of ~18°C between 15-30 metres water depth. This situation precludes any mixing of surface and deep water.

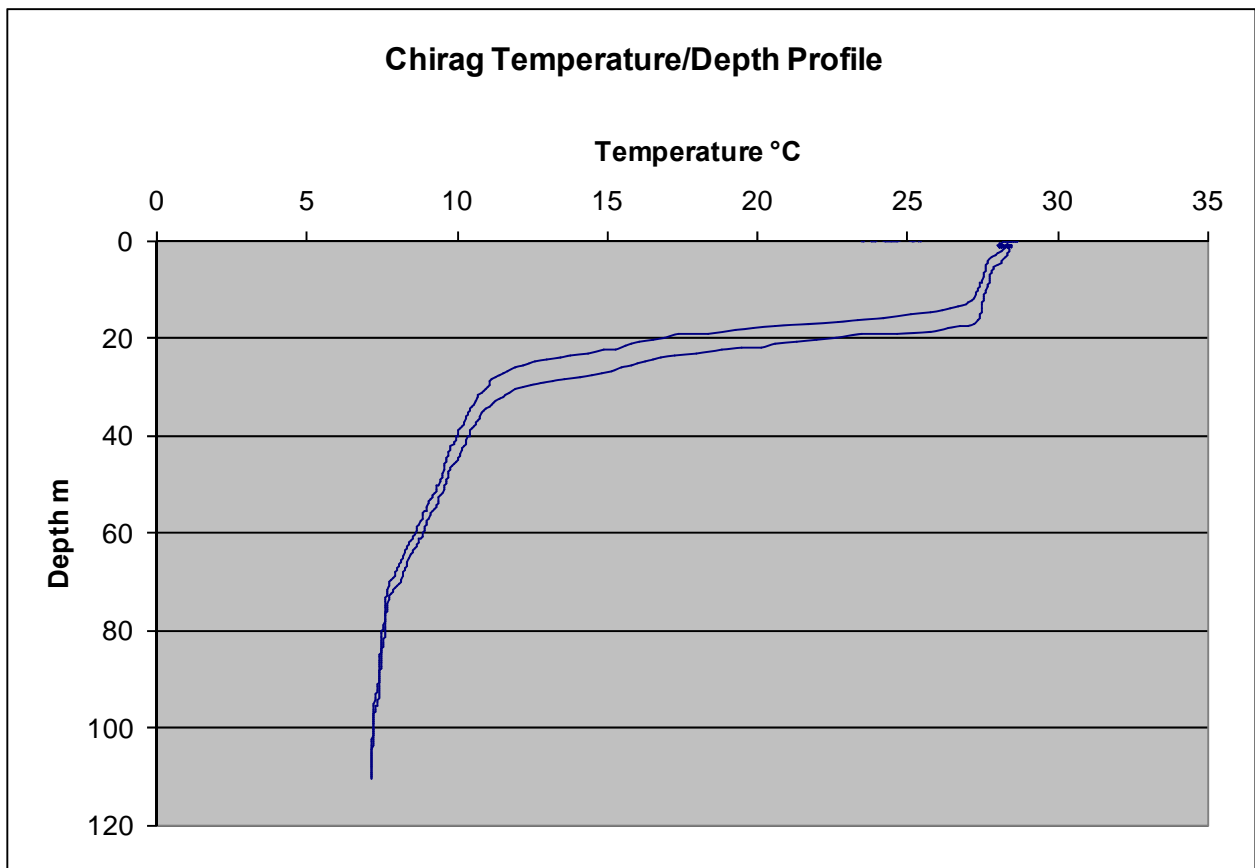


Figure 8.1 Temperature/Depth Profile, Chirag Survey, August 2010

8.2. Analytical Results

8.2.1. On deck Measurements

The results of on deck chemical and physical analyses are summarised in table 8.1. Comparable data from the 2008 Chirag survey is given in table 8.2.

Table 8.1 On deck Analyses of Water Samples, Chirag Survey 2010

| Station Number | Depth | DO mg.l ⁻¹ | Temp °C | Salinity PSU | pH | Cond mS/cm | Turb NTU |
|----------------|---------|-----------------------|---------|--------------|------|------------|----------|
| 1 | Surface | 6.87 | 27 | 11.2 | 8.37 | 18.85 | 0.54 |
| | 50 m | 7.63 | 12.6 | 11.2 | 8.31 | 19.05 | 0.19 |
| 8 | Surface | 6.88 | 27.7 | 11.1 | 8.38 | 18.70 | 0.39 |
| | 50 m | 7.46 | 12.3 | 11.3 | 8.30 | 19.54 | 0.28 |
| | 100 m | 5.82 | 10.8 | 11.1 | 8.11 | 18.91 | 0.04 |
| 9 | Surface | 6.82 | 27.3 | 11.2 | 8.39 | 18.72 | 0.30 |
| | 100 | 5.72 | 10.9 | 11.2 | 8.11 | 19.01 | 0.07 |
| 15 | Surface | 6.88 | 27.2 | 11.3 | 8.38 | 18.84 | 0.22 |
| | 100 | 5.92 | 10.2 | 11.2 | 8.09 | 19.14 | 0.13 |

Table 8.2 On deck Analyses of Water Samples, Chirag Survey 2008

| Station Number | Depth | DO mg.l ⁻¹ | Temp °C | Salinity PSU | pH | Cond mS/cm | Turb NTU |
|----------------|---------|-----------------------|---------|--------------|------|------------|----------|
| 1 | Surface | 8.08 | 23.4 | 11.1 | 8.37 | 18.82 | 1.54 |
| | 50 | 8.38 | 15.9 | 11 | 8.22 | 18.68 | 1.47 |
| 8 | Surface | 7.27 | 22.6 | 11.1 | 8.43 | 18.82 | 1.56 |
| | 50 | 9.53 | 15.5 | 11 | 8.24 | 18.7 | 1.52 |
| | 100 | 7.9 | 14.9 | 11.1 | 8.08 | 18.84 | 1.06 |
| 9 | Surface | 7.36 | 22.4 | 11.2 | 8.44 | 18.81 | 0.98 |
| | 50 | 8 | 14.2 | 11.1 | 8.29 | 18.75 | 1.55 |
| 15 | Surface | 6.96 | 23.3 | 11.2 | 8.39 | 18.87 | 2.25 |
| | 50 | 9.05 | 14.5 | 11 | 8.24 | 18.75 | 1.57 |

Dissolved oxygen fluctuated between samples and depth and was higher in samples taken from 50m and lowest in samples from 100m. Concentrations ranged from 5.72- 7.63mg.l⁻¹.

There was little variation in salinity and conductivity which ranged from 11.1 -11.3 PSU and 18.70-19.54mS/cm respectively.

Although the variation was low pH reduced with depth. The pH of surface waters ranged from 8.37 - 8.38 and reduced to 8.30 & 8.31 at 50m. The pH at 100m ranged from 8.09-8.11.

Turbidity was highest in surface waters and reduced with depth. Turbidity in surface samples ranged from 0.22-0.54 NTU with 0.19 & 0.28NTU at 50m and 0.04-0.13NTU at 100m.

When compared to the data from the 2008 Chirag survey, DO concentration and the turbidity NTU values were higher in 2008.

8.2.2. Laboratory Analytical Results

BOD, COD & Nutrient Analysis

The results of the oxygen demand, nutrients and total suspended solids are given in table 8.3 and the comparable data from the 2008 Chirag Survey in table 8.4.

Total Suspended Solids

TSS values were above the detectable limit of 2mg.l^{-1} in all surface samples and ranged from $2.4 - 3.0 \text{mg.l}^{-1}$.

Biological and Chemical Oxygen Demand

Levels of BOD and COD measured in all samples were below the detection limit of the methods.

Nitrogen Compounds

All samples had nitrite concentrations below the $0.2\mu\text{g.l}^{-1}$ detection limit. Nitrate concentrations were below the detectable limit of $10\mu\text{g.l}^{-1}$ in all surface water samples. The highest concentrations were recorded at 100m and ranged from $27-43.2 \mu\text{g.l}^{-1}$.

Ammonium concentrations ranged from below the detectable limit of $10\mu\text{g.l}^{-1}$ to $11\mu\text{g.l}^{-1}$.

Total N fluctuated between sample stations and depths. The ranges in concentrations were $240-503\mu\text{g.l}^{-1}$ in surface samples, $265 \& 269\mu\text{g.l}^{-1}$ at 50m and $96-264\mu\text{g.l}^{-1}$ at 100m.

Phosphorus Compounds

Other than the sample taken from 100m at station 8 where the concentration was $1.8\mu\text{g.l}^{-1}$, all samples had phosphate concentrations below the detectable limit of $1.6\mu\text{g.l}^{-1}$.

Total P concentrations were higher in surface samples with concentrations ranging from $9-11\mu\text{g.l}^{-1}$. Concentrations at 50 and 100m ranged from $3-8\mu\text{g.l}^{-1}$.

Silicates

Silicate concentrations varied between stations and depths. The highest concentrations were recorded at 100m with $295-536\mu\text{g.l}^{-1}$. Concentrations ranged from $27-53\mu\text{g.l}^{-1}$ in surface samples with 125 and $88\mu\text{g.l}^{-1}$ being recorded at 50m.

When compared to the 2008 Chirag data, ammonium, total N, phosphorous and total P concentrations were higher in the samples taken in 2008, whereas nitrate concentrations taken at 100m were higher in 2010 data.

Organic Compounds

The 2010 results for all hydrocarbon parameters were below the detection limits of $20\mu\text{g.l}^{-1}$ for THC and $0.010 \mu\text{g.l}^{-1}$ USEPA 16 PAH (table 8.5) in all samples.

Samples were analysed for individual phenol compounds. The concentration of all phenols were below the detectable limit in all samples. The detectable limit for each phenol compound is given in table 8.7.

Similar results were recorded in the 2008 Chirag survey (tables 8.6 and 8.8).

Metals

The results of the metal analysis are given on table 8.9. The comparable data from the 2008 Survey is given in table 8.10.

Iron concentrations fluctuated between stations and depths and ranged from below the detection limit of 2.0 to a maximum of 4.3 $\mu\text{g.l}^{-1}$.

Cobalt concentrations were above the detection limit of 0.02 $\mu\text{g.l}^{-1}$ in the surface sample at station 1 and from the surface and 50m sample at station 8. The concentrations in these samples ranged from 0.029-0.041 $\mu\text{g.l}^{-1}$.

There was little variation in nickel concentrations which ranged from 0.752-1.140 $\mu\text{g.l}^{-1}$.

Higher copper concentrations were generally found in surface samples with concentrations ranging from 0.665 to 1.250 $\mu\text{g.l}^{-1}$. At 50 and 100m, concentrations ranged from 0.484 to 0.786 $\mu\text{g.l}^{-1}$.

The highest zinc concentration was observed in the surface sample from station 8 with 7.05 $\mu\text{g.l}^{-1}$. The concentration in all other samples ranged from 0.98 to 3.44 $\mu\text{g.l}^{-1}$. There was a tendency for higher concentrations being present in surface samples.

All samples had cadmium concentrations below the detection limit of 0.02 $\mu\text{g.l}^{-1}$.

Lead concentrations fluctuated with position and depth and ranged from below the detection limit of 0.10 $\mu\text{g.l}^{-1}$ to a maximum of 1.46 $\mu\text{g.l}^{-1}$ in the surface sample from station 1.

Zinc and lead concentrations observed in 2010 were higher than the corresponding results from 2008. All other results were similar to those recorded in the 2008 survey. Results for all parameters were within the MAC for Azerbaijan fisheries waters.

Table 8.3 BOD-5, COD and nutrients analysis results Chirag Survey 2010

| Station | Depth | TSS mg.l ⁻¹ | BOD-5 mg.l ⁻¹ | COD mg.l ⁻¹ | Nitrites NO ₂ -N µg.l ⁻¹ | Nitrates NO ₂₊₃ -N µg.l ⁻¹ | Ammonium NH ₄ -N µg.l ⁻¹ | Total N µg.l ⁻¹ | Phosphates PO ₄ -P µg.l ⁻¹ | Total P µg.l ⁻¹ | Silicates SiO ₂ -Si µg.l ⁻¹ |
|---------|---------|---------------------------|-----------------------------|---------------------------|--|--|--|-------------------------------|--|-------------------------------|---|
| 1 | Surface | 3 | <0.5 | <4.0 | <0.2 | <10 | <10 | 503 | <1.6 | 9 | 53 |
| | 50 m | <2.0 | <0.5 | <4.0 | <0.2 | 22.4 | 10 | 265 | <1.6 | 7 | 125 |
| 8 | Surface | 2.7 | <0.5 | <4.0 | <0.2 | <10 | 10 | 333 | <1.6 | 11 | 60 |
| | 50 m | <2.0 | <0.5 | <4.0 | <0.2 | <10 | <10 | 269 | <1.6 | 7 | 88 |
| | 100 m | <2.0 | <0.5 | <4.0 | <0.2 | 27 | <10 | 96 | 1.8 | 3 | 295 |
| 9 | Surface | 2.6 | <0.5 | <4.0 | <0.2 | <10 | <10 | 286 | <1.6 | 9 | 48 |
| | 100 | <2.0 | <0.5 | <4.0 | <0.2 | 31.7 | <10 | 241 | <1.6 | 6 | 536 |
| 15 | Surface | 2.4 | <0.5 | <4.0 | <0.2 | <10 | <10 | 240 | <1.6 | 9 | 27 |
| | 100 | <2.0 | <0.5 | <4.0 | <0.2 | 43.2 | 11 | 264 | <1.6 | 8 | 455 |
| MAC | | <0.75 | <3.0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

Table 8.4 BOD-5, COD and nutrients analysis results Chirag Survey 2008

| Station Number | Depth | TSS, mg.l ⁻¹ | BOD-5, mg.l ⁻¹ | COD, mg.l ⁻¹ | Nitrites NO ₂ -N µg.l ⁻¹ | Nitrates NO ₂₊₃ -N µg.l ⁻¹ | Ammonium NH ₄ -N µg.l ⁻¹ | Total N µg.l ⁻¹ | Phosphates, PO ₄ -P µg.l ⁻¹ | Total P µg.l ⁻¹ | Silicates SiO ₂ -Si µg.l ⁻¹ |
|----------------|---------|----------------------------|------------------------------|----------------------------|--|--|--|-------------------------------|---|-------------------------------|---|
| 1 | Surface | <2.0 | <0.5 | <4.0 | 0.92 | <10 | 17 | 470 | 4.4 | 18 | 45 |
| | 50m | <2.0 | <0.5 | <4.0 | 0.98 | <10 | 10 | 530 | 1.8 | 19 | 74.8 |
| 8 | Surface | 2.3 | <0.5 | <4.0 | 0.8 | <10 | 13 | 620 | 3.1 | 16 | 53 |
| | 50m | <2.0 | <0.5 | <4.0 | 1.32 | <10 | 12 | 464 | 2 | 12 | 50 |
| | 100m | <2.0 | <0.5 | <4.0 | 0.66 | <10 | 11 | 479 | 2.1 | 13 | 370 |
| 9 | Surface | <2.0 | <0.5 | <4.0 | 1.08 | <10 | 10 | 530 | 4.6 | 21 | 50.4 |
| | 50m | <2.0 | <0.5 | <4.0 | 2.38 | <10 | <10 | 490 | 2.3 | 20 | 29.2 |
| 15 | Surface | 3.3 | <0.5 | <4.0 | 0.62 | <10 | <10 | 530 | 5.4 | 18 | 79.6 |
| | 50m | <2.0 | <0.5 | <4.0 | 0.76 | <10 | 12 | 530 | 2 | 15 | 67.2 |

Table 8.5 Hydrocarbons in Water Samples, Chirag Survey 2010

| Station Number | Depth | THC $\mu\text{g.l}^{-1}$ | 16 US EPA PAH $\mu\text{g.l}^{-1}$ |
|----------------|----------------------|--------------------------|------------------------------------|
| 1 | Surface | <20 | <0.01 |
| | 50 m | <20 | <0.01 |
| 8 | Surface | <20 | <0.01 |
| | 50 m | <20 | <0.01 |
| | 100 m | <20 | <0.01 |
| 9 | Surface | <20 | <0.01 |
| | 100 | <20 | <0.01 |
| 15 | Surface | <20 | <0.01 |
| | 100 | <20 | <0.01 |
| MAC | $\mu\text{g.l}^{-1}$ | 50 | Not available |

Table 8.6 Hydrocarbons in Water Samples, Chirag Survey 2008

| Station Number | Depth | THC $\mu\text{g.l}^{-1}$ | 16 US EPA PAH $\mu\text{g.l}^{-1}$ |
|----------------|----------------------|--------------------------|------------------------------------|
| 1 | Surface | <20 | <0.01 |
| | 50m | <20 | <0.01 |
| 8 | Surface | <20 | <0.01 |
| | 50m | <20 | <0.01 |
| | 100m | <20 | <0.01 |
| 9 | Surface | <20 | <0.01 |
| | 50m | <20 | <0.01 |
| 15 | Surface | <20 | <0.01 |
| | 50m | <20 | <0.01 |
| MAC | $\mu\text{g.l}^{-1}$ | 50 | Not available |

Table 8.7 Phenol Concentrations in All individual Water Samples, Chirag Survey 2010

| <i>Phenols#, µg.l⁻¹</i> | |
|---|----------------------|
| Compound | Concentration |
| Phenol | <0.02 |
| 2-methylphenol (o-cresol) | <0.02 |
| 3, 4 -methylphenol (m,p-cresol) | <0.01 |
| 2,4-Dimethylphenol | <0.02 |
| 2-Nitrophenol | <0.04 |
| 2-sec-Butyl-4,6-dinitrophenol (Dinoseb) | <0.08 |
| 2,4-Dichlorophenol | <0.02 |
| 2,6-Dichlorophenol | <0.02 |
| 4-Chloro-3-methylphenol | <0.04 |
| 2,4,5-Trichlorophenol | <0.04 |
| 2,4,6-Trichlorophenol | <0.04 |
| 2,3,4,6-Tetrachlorophenol | <0.04 |
| 2-Methyl-4,6-dinitrophenol | <0.04 |
| Pentachlorophenol | <0.04 |
| MAC | 1 |

Table 8.8 Phenol Concentrations in All individual Water Samples, Chirag Survey 2008

| <i>Phenols#, µg.l⁻¹</i> | |
|---|----------------------|
| Compound | Concentration |
| Phenol | <0.02 |
| 2-methylphenol (o-cresol) | <0.02 |
| 3, 4 -methylphenol (m,p-cresol) | <0.01 |
| 2,4-Dimethylphenol | <0.02 |
| 2-Nitrophenol | <0.04 |
| 2-sec-Butyl-4,6-dinitrophenol (Dinoseb) | <0.08 |
| 2,4-Dichlorophenol | <0.02 |
| 2,6-Dichlorophenol | <0.02 |
| 4-Chloro-3-methylphenol | <0.04 |
| 2,4,5-Trichlorophenol | <0.04 |
| 2,4,6-Trichlorophenol | <0.04 |
| 2,3,4,6-Tetrachlorophenol | <0.04 |
| 2-Methyl-4,6-dinitrophenol | <0.04 |
| Pentachlorophenol | <0.04 |
| MAC | 1 |

Table 8.9 Metals in Water, Chirag Survey 2010

| Station Number | Depth | Iron $\mu\text{g.l}^{-1}$ | Cobalt $\mu\text{g.l}^{-1}$ | Nickel $\mu\text{g.l}^{-1}$ | Copper $\mu\text{g.l}^{-1}$ | Zinc $\mu\text{g.l}^{-1}$ | Cadmium $\mu\text{g.l}^{-1}$ | Lead $\mu\text{g.l}^{-1}$ |
|-----------------------------|---------|---------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|------------------------------|---------------------------|
| 1 | Surface | 4.3 | 0.037 | 0.911 | 1.250 | 3.44 | <0.02 | 1.46 |
| | 50 m | <2.0 | <0.02 | 0.923 | 0.653 | 1.26 | <0.02 | <0.1 |
| 8 | Surface | 2.7 | 0.029 | 1.090 | 0.843 | 7.05 | <0.02 | 0.578 |
| | 50 m | <2.0 | 0.041 | 0.931 | 0.484 | 0.984 | <0.02 | <0.1 |
| | 100 m | 2.1 | <0.02 | 1.140 | 0.546 | 1.34 | <0.02 | <0.1 |
| 9 | Surface | <2.0 | <0.02 | 0.752 | 1.070 | 2 | <0.02 | 0.214 |
| | 100 | 3.4 | <0.02 | 1.110 | 0.786 | 2.24 | <0.02 | 0.223 |
| 15 | Surface | <2.0 | <0.02 | 0.976 | 0.665 | 1.85 | <0.02 | <0.1 |
| | 100 | 2.1 | <0.02 | 0.880 | 0.714 | 1.61 | <0.02 | <0.1 |
| MAC Fisheries Waters | | NA | 10 | 10 | 10 | 10 | 5 | 100 |

Table 8.10 Metals in Water, Chirag Survey 2008

| Station Number | Depth | Iron $\mu\text{g.l}^{-1}$ | Cobalt $\mu\text{g.l}^{-1}$ | Nickel $\mu\text{g.l}^{-1}$ | Copper $\mu\text{g.l}^{-1}$ | Zinc $\mu\text{g.l}^{-1}$ | Cadmium $\mu\text{g.l}^{-1}$ | Lead $\mu\text{g.l}^{-1}$ |
|-----------------------------|---------|---------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|------------------------------|---------------------------|
| 1 | Surface | <10 | 0.026 | 1.180 | 0.736 | 0.48 | 0.011 | 0.047 |
| | 50m | <10 | 0.020 | 0.916 | 0.693 | 0.32 | 0.009 | 0.025 |
| 8 | Surface | <10 | 0.026 | 0.935 | 0.724 | 0.52 | 0.011 | 0.301 |
| | 50m | <10 | 0.019 | 0.896 | 0.664 | 0.35 | 0.010 | 0.027 |
| | 100m | <10 | 0.014 | 0.948 | 0.628 | 0.65 | 0.012 | 0.032 |
| 9 | Surface | <10 | 0.027 | 0.940 | 0.733 | 0.57 | 0.015 | 0.077 |
| | 50m | <10 | 0.018 | 0.890 | 0.657 | 0.48 | 0.009 | 0.029 |
| 15 | Surface | <10 | 0.024 | 0.893 | 0.679 | 0.35 | 0.011 | 0.049 |
| | 50m | <10 | 0.018 | 1.011 | 0.679 | 0.37 | 0.010 | 0.026 |
| MAC Fisheries Waters | | NA | 10 | 10 | 10 | 10 | 5 | 100 |

Summary

The water column of the Chirag survey area was found to be strongly stratified, with a temperature difference of $\sim 18^{\circ}\text{C}$ between 15-30 metres.

Surface waters were found to have a higher turbidity, TSS and pH, and higher concentrations of total P, Co and Zn. Whereas samples taken below the thermocline were higher in silicates.

Results for BOD, COD, Cd, and all hydrocarbon parameters were below the limit of detection in all samples.

When compared to the data collected during the 2008 Chirag survey, all 2010 Chirag results are very similar. The only exception was higher Pb and Zn concentrations in 2010.

Other than the concentration of TSS all results were below the MAC for fisheries waters, no evidence of contamination from the platform was observed.