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SEDIMENT SETTLING RATE ANALYSES FOR A SEDIMENT STABILITY STUDY OF THE INNER MIRAMICHI BAY, NEW BRUNSWICK

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I. Background and Objectives

As part of a programme to evaluate the physical characteristics and stability of sediments within the Inner Bay of the Miramichi Estuary, settling rate measurements were carried out on four bulk seabed samples collected with a medium Van Veen grab sampler. Samples were taken from the Control Site (Station 1), a 1990 spoils mound at Dump Site B (Station 7), in the area of Reach 22 of the dredged channel (Station 13), and in the area of Reach 20 of the dredged channel (Station 18). The exact location of each sample is documented in Brylinsky *et al.* (1992). Sub-samples from each of the four sites were prepared for a series of settling rate tests at starting suspended sediment concentrations ranging between 2-40 g/L, and at salinities ranging between 13-30 ‰. These are considered to cover the range of probable conditions prevalent within the Miramichi Inner Bay.

The objectives of this study were: (1) to determine the conditions under which hindered settling and fluid mud generation takes place; and (2) to determine the relationship between mass settling rate and initial sediment concentration and salinity.

II. Methodology

Bulk samples were split and wet sieved through a 64 micron mesh in order to remove the sand fraction. The finer fraction was mixed with seawater to a known starting suspended sediment concentration and then thoroughly mixed within a settling column. The settling column consisted of a 40 cm high, 6 cm dia cylinder, a size previously shown to be free of problems associated with wall effects (Lovell and Rose 1991). Changes in sediment concentration with time were measured by reference to fluid density with a calibrated hydrometer. Hydrometer measures were taken at intervals of 1, 2, 3, 5, 10, 15, 20, 30, 45 and 60 min after initiation of each experiment. The water temperature of each experiment was between 20-22 °C.

III. Results

A total of 119 experiments were carried out: 29 on the Control Site sample, 30 on the Dump Site sample, 30 on the sample from Reach 22, and 30 on the sample from Reach 20. In general, sediment concentration versus time showed an exponential decrease that appeared to be bimodal; an initial rapid drop in concentration within several minutes was followed by a slow rate of settling that took place over several hours. Figures of all time series together with regression analyses of the trends are shown in Appendix I. The inflection point between the two modes of settling is at a constant concentration of circa 4 g/L at initial sediment concentrations (C_0) below 20 g/L. Above 20 g/L the inflection point occurs at approximately twice this value (Figure 1). This indicates that hindered settling and the potential for fluid mud development occurs at C_0 >20 g/L. This inflection point is independent of salinity (Figure 2).

In order to quantify the results two models of sedimentation were tested: (1) a linear model of particle settling through time whereby:

$$C_t = C_0 - k_{lin}t \qquad \text{where,}$$

C_t = Concentration at time t
C_0 = Concentration at time 0
k_{lin} = slope
t = time

and (2) the model of Krone (1962) whereby the still water rate of change in concentration is related to mass settling velocity (V_0) in exponentially decaying form as follows:

$C_t = C_0 \exp [-ptk_{log}]$ where,

C_t = Concentration at time t
C_0 = Concentration at time 0
p = probability of particle deposition
t = time
k_{log} = slope

The probability of particle deposition (p) for still water is set to 1. k_{log} is equal to V_0/y (units of 1/s) where y is the depth below the water surface at which V_0 is evaluated. This depth varied, due to changes in water density, between 12 and 17 cm. Nevertheless, we adopted an average of 14 cm throughout this study.

Reasonable fits of the observations to either model could not be achieved by considering the concentration decay as a whole. Much better results were achieved by fitting curves to trends either side of the inflection point. Appendix I presents regression coefficients for both the linear and exponential decay models. The slope of the initial trend is defined as K1 whereas the latter is referred to as K2. Regression coefficients >0.90 were obtained in most instances.

Figures 3-6 illustrate the relationship between C_0 and slope for the linear and exponential decay models. $K1_{lin}$ showed a strong linear relationship to C_0 to about 20 g/L. For the period of initial rapid settling slopes based on the linear model were best correlated to C_0. Correlation coefficients in excess of 0.88 were thus achieved (Figure 3). A poorer but nevertheless significant fit was also achieved using slopes based on the exponential decay model. For C_0 <20 g/L this model yielded correlation coefficients between 0.12 and 0.83 (Figure 4).

In all but the Reach 22 case, $K1_{lin}$ is small (<-0.5) and apparently constant below 2 g/L. Note the position of the intercept of the best fit lines at circa 2 g/L in Figure 3. This we interpret as the region of floc settling where flocs settle independent of other flocs in suspension. For a $K1_{lin}$ = -0.5 and using the transform of Krone (1972):

$$V_0 = |K1_{lin}|/14 = 0.036 \text{ cm/s}$$

This value of V_0 is very close to values reported by Amos and Mosher (1985) from analysis of suspended sediments from the Bay of Fundy using a bottom withdrawal method.

Between a concentration range of 2-20 g/L we interpret conditions of mass settling. The trends in $K1_{lin}$ between the control site, Dump Site B, and Reach 20 appear to be similar, with $K1_{lin}$ attaining a minimum value on the order of -6 to -7. The Reach 22 sample, by contrast, shows evidence of a generally lower rate of settling at a given starting concentration.

The following are the linear equations describing $K1_{lin}$ as a function of C_0 for the four sites described in this study:

Control Site: $K1_{lin} = 1.352 - 0.387(C_0)$; $[2< C_0 <20$ g/L]

Dump Site B: $K1_{lin} = 0.620 - 0.276(C_0)$; $[2< C_0 <20$ g/L]

Reach 22: $K1_{lin} = -0.285 - 0.177(C_0)$; $[2< C_0 <20$ g/L]

Reach 20: $K1_{lin} = -0.774 - 0.364(C_0)$; $[2 < C_0 < 20$ g/L]

Above 20 g/L, $K1_{lin}$ appeared to remain constant and high. We presume that this represents the beginning of conditions of hindered settling though we note the settling rate is no less than under conditions of mass settling. In all cases where $C_0 > 20$ g/L, $K1_{lin}$ is equated with its value at 20 g/L.

The period of slow settling was best approximated by a logarithmic model (Appendix 1). The value of K2 in both the linear and log model was circa -0.03 (Figures 5 and 6). This yielded a mass settling rate of 2.1×10^{-5} m/s.

The direct relationship between settling rate and suspended sediment concentration is clearly seen in Figures 7 to 10. Notice in each case the monotonic decrease in $K1_{lin}$ with sediment concentration through the mass settling range and the lack of correlation with salinity. This trend breaks down in the region of hindered settling such that $K1_{lin}$ appears independent of both salinity and concentration. At concentrations >20 g/L, there is a change in the trend of $K1_{lin}$ with an associated decrease in mass settling rate. This may herald the onset of conditions leading to the development of fluid muds (Wolanski *et al.* 1992).

IV. References

Amos, C.L. and D.C. Mosher. 1985. Erosion and deposition of fine-grained sediments from the Bay of Fundy. Sedimentology 32:815-832.

Brylinsky, M., A.J. Gibson, G.R. Daborn, C.L. Amos and H.A. Christian. 1992. Miramichi Inner Bay Sediment Stability Study. Report to Public Works Canada: Contract No. 2105182. Acadia Centre for Estuarine Research Publication No. 22. Acadia University, Wolfville, Nova Scotia.

Krone, R.B. 1962. Flume studies of the transport of sediment in estuarial shoaling processes. *Final rep.* Hydraulic Engineering Laboratory and Sanitary Engineering Research Laboratory, University of California, Berkeley.

Lovell, C.J. and C.W. Rose. 1991. The effect of sediment concentration and tube-diameter on particle settling velocity measured beyond Stokes' range: experiments and theory. Journal of Sedimentary Petrology. 61(4):583-589.

Wolanski, E., R.J. Gibbs, Y. Mazda, A. Mehta and B. King. 1992. The role of turbulence in the settling of mud flocs. Journal of Coastal Research. 8(1):35-64.

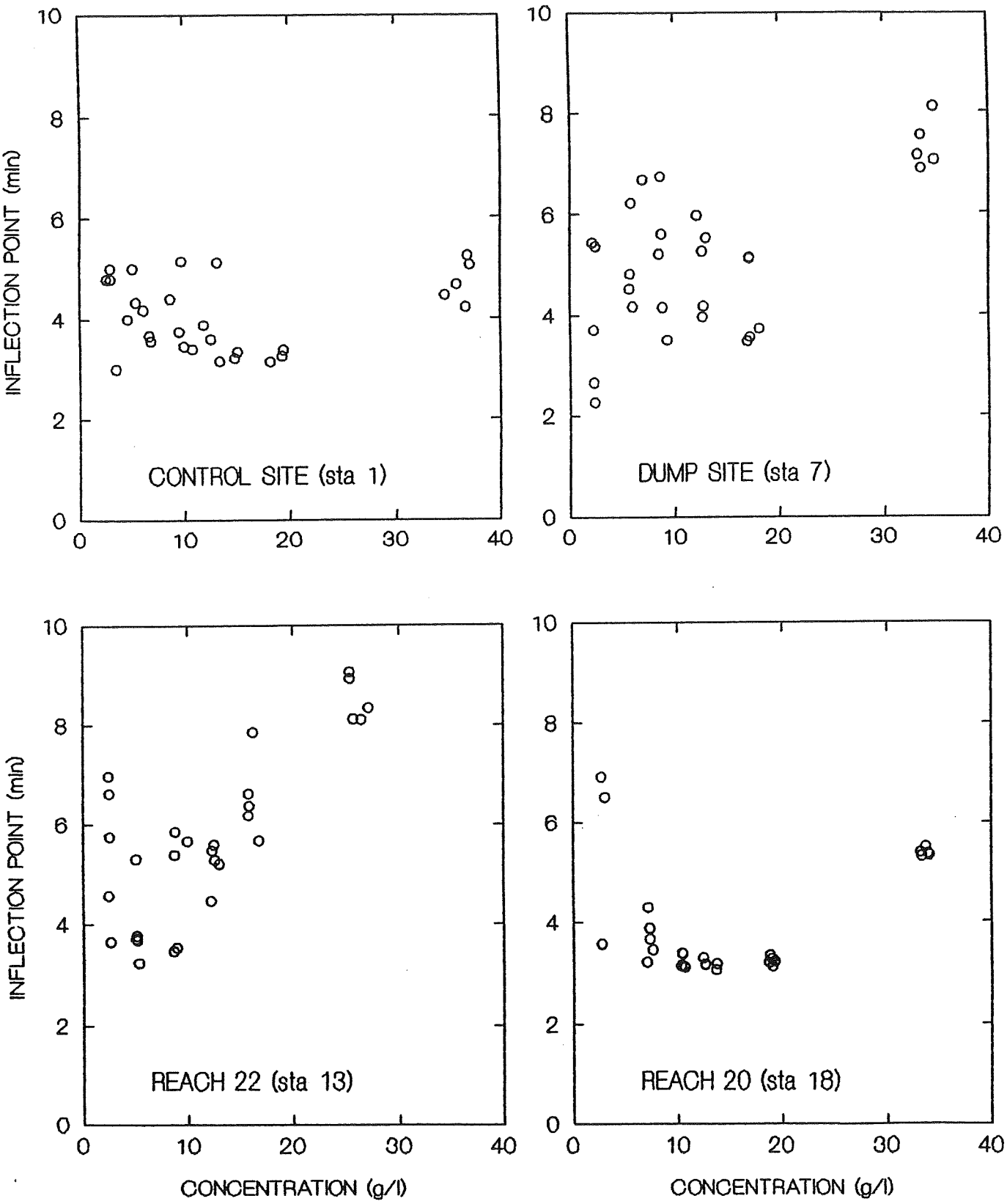


Figure 1. Relationship between initial suspended sediment concentration and the inflection point separating the two modes of settling.

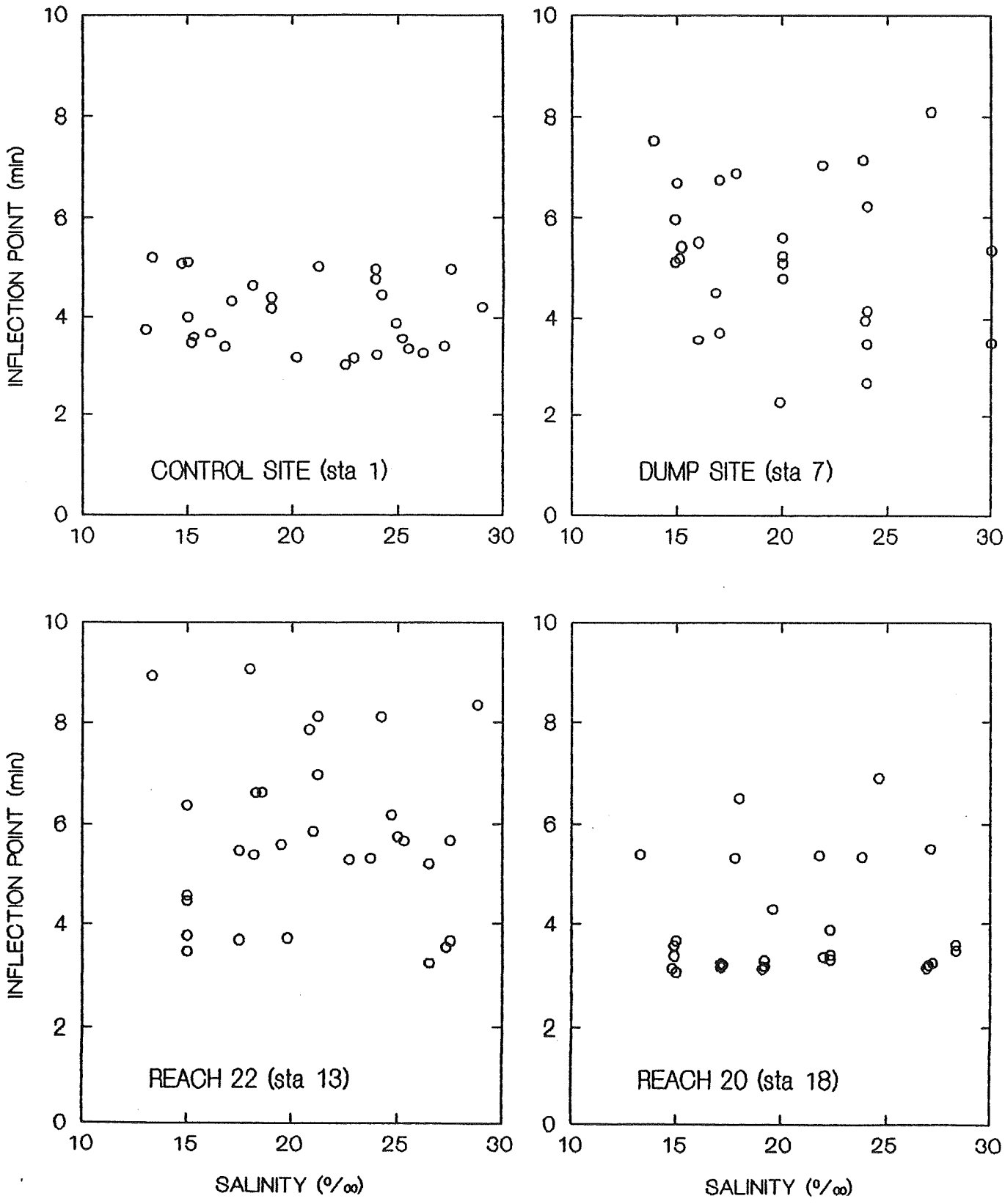


Figure 2. Relationship between salinity and the inflection point separating the two modes of settling.

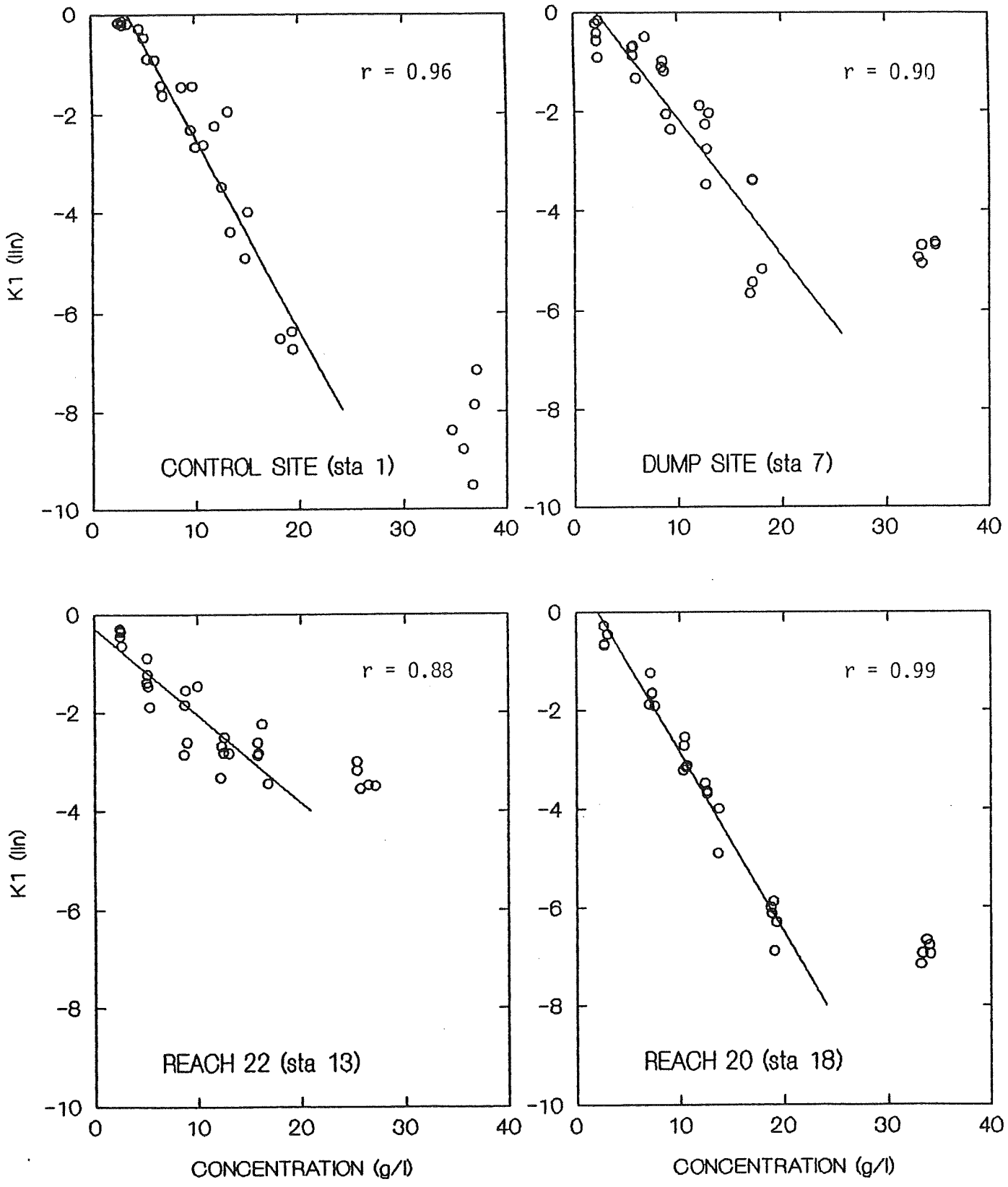


Figure 3. Relationship between $K1_{lin}$ and initial suspended sediment concentration (r^2 values are based on data for C_0 < 20 g/L).

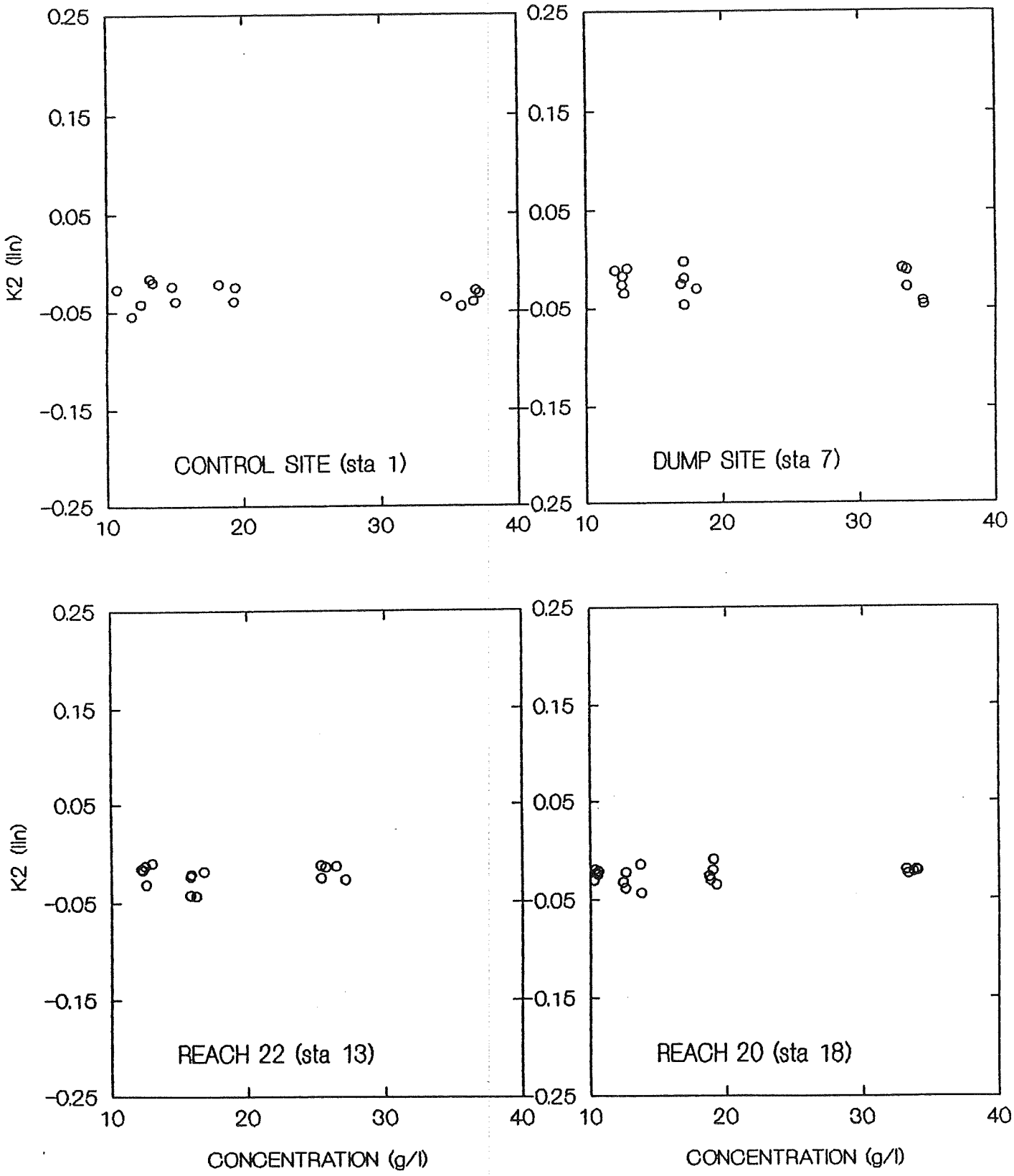


Figure 4. Relationship between $K2_{lin}$ and initial suspended sediment concentration.

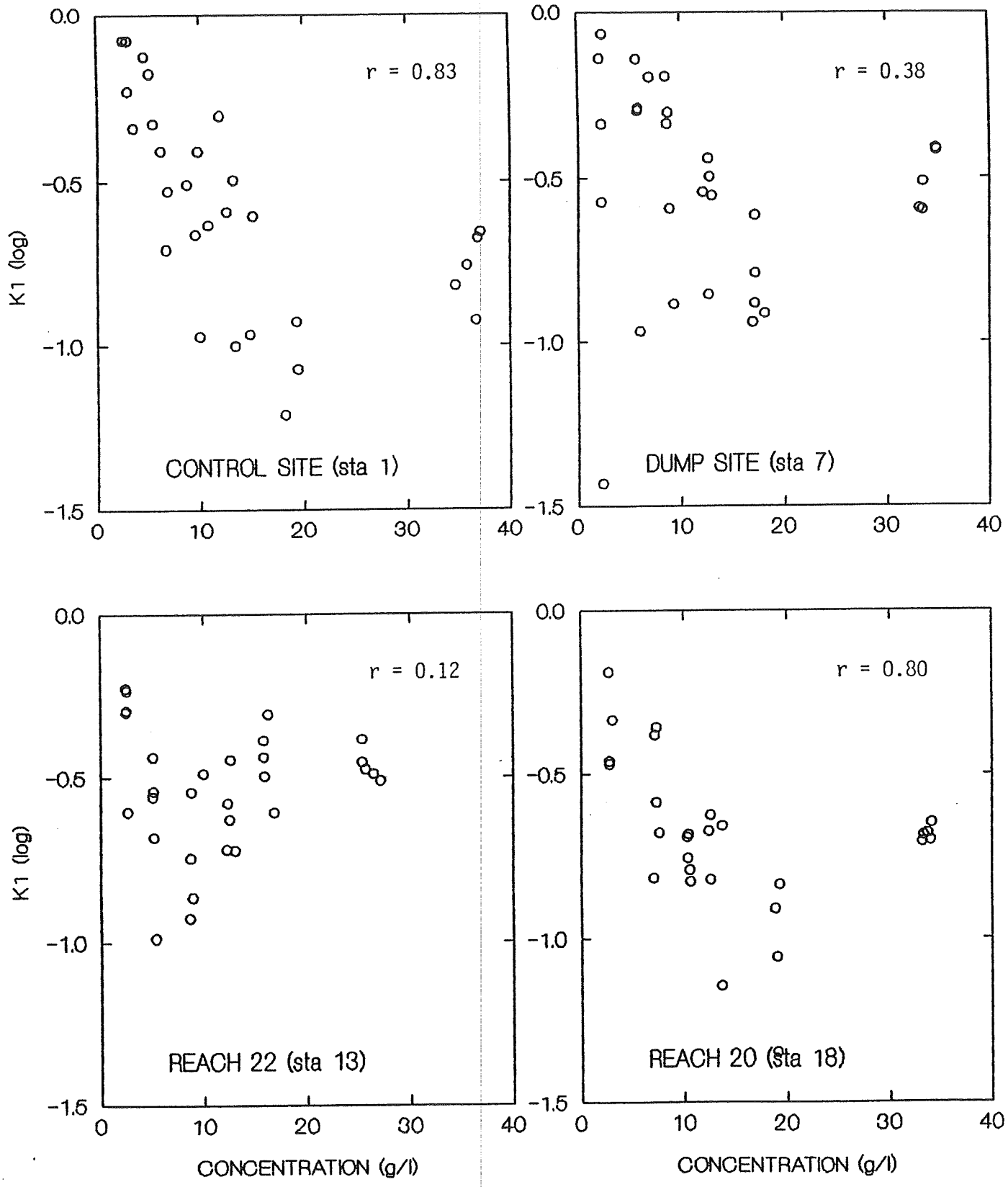


Figure 5. Relationship between $K2_{log}$ and initial suspended sediment concentration (r^2 values are based on data for $C_0 < 20$ g/L).

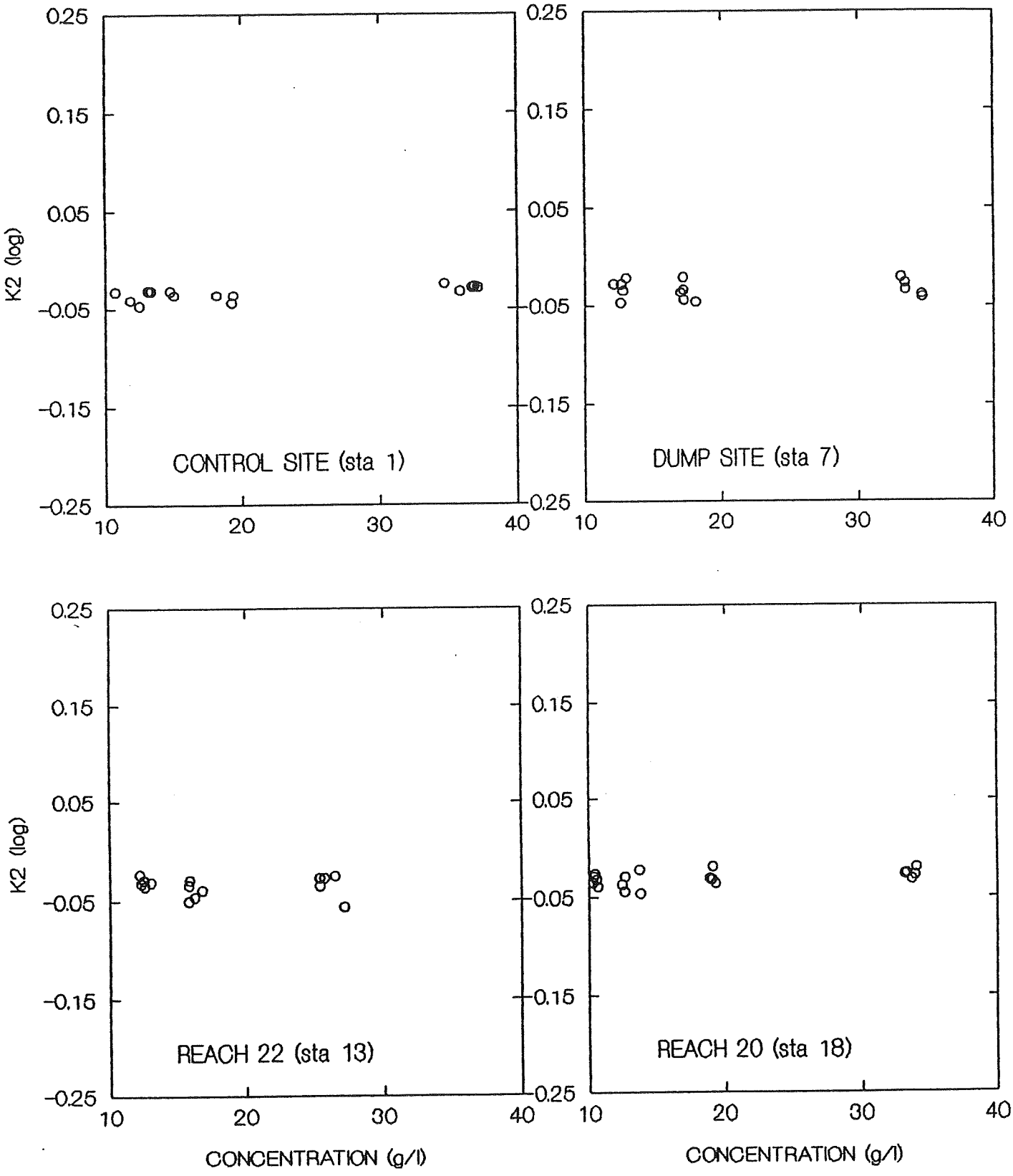


Figure 6. Relationship between $K2_{log}$ and initial suspended sediment concentration.

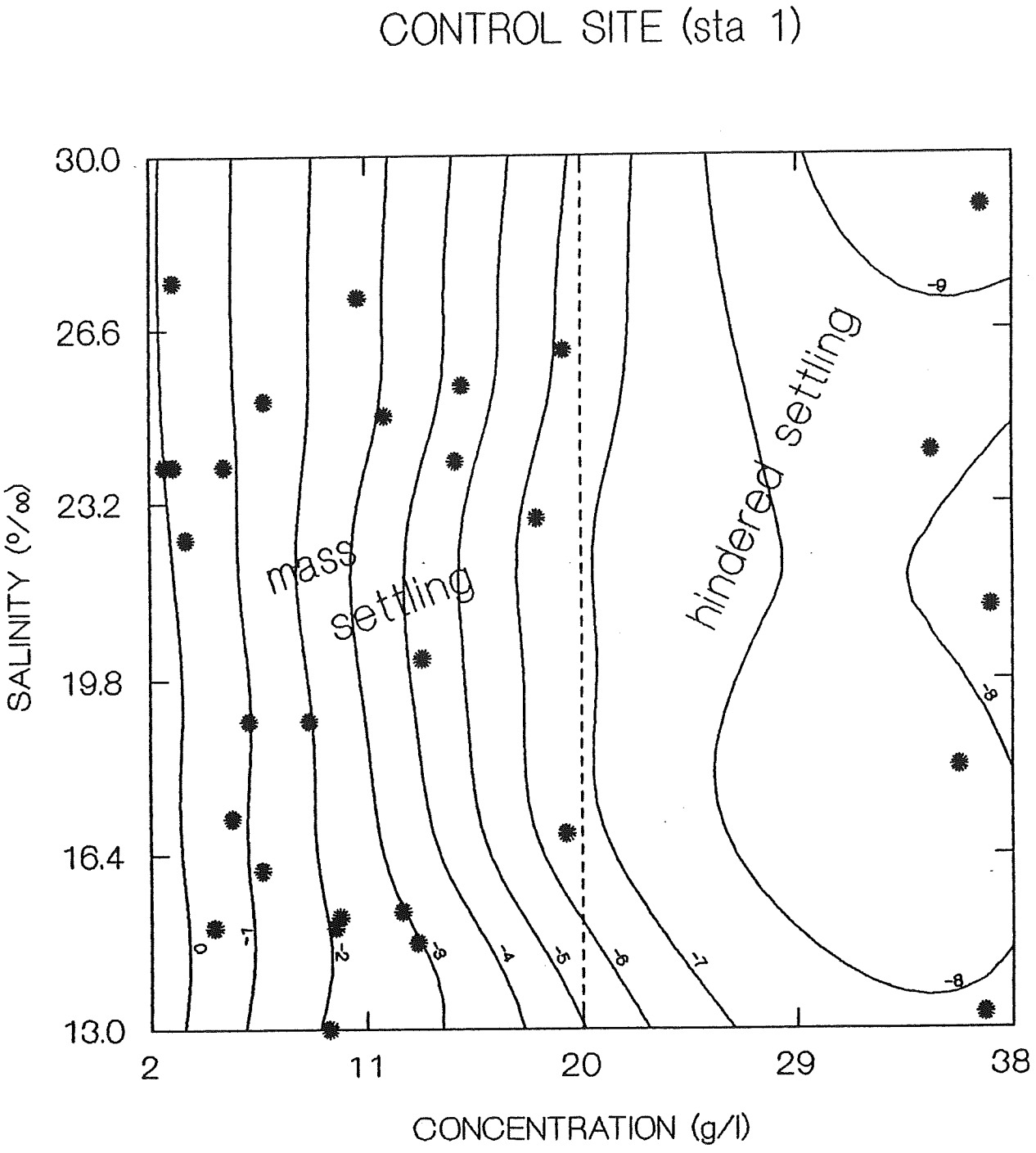


Figure 7. $K1_{lin}$ as a function of initial suspended sediment concentration and salinity for the Control Site sample.

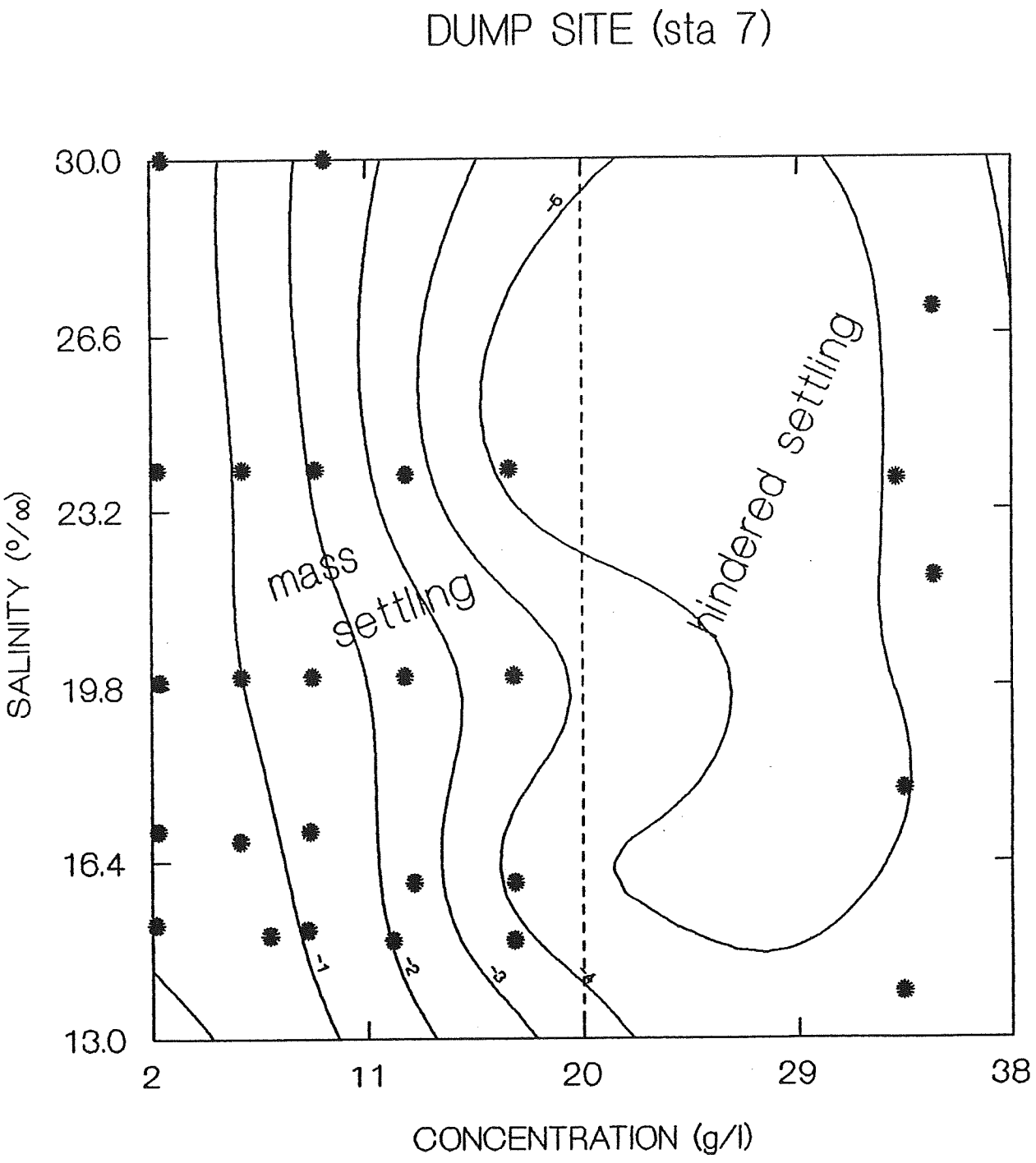


Figure 8. $K1_{lin}$ as a function of initial suspended sediment concentration and salinity for the Dump Site sample.

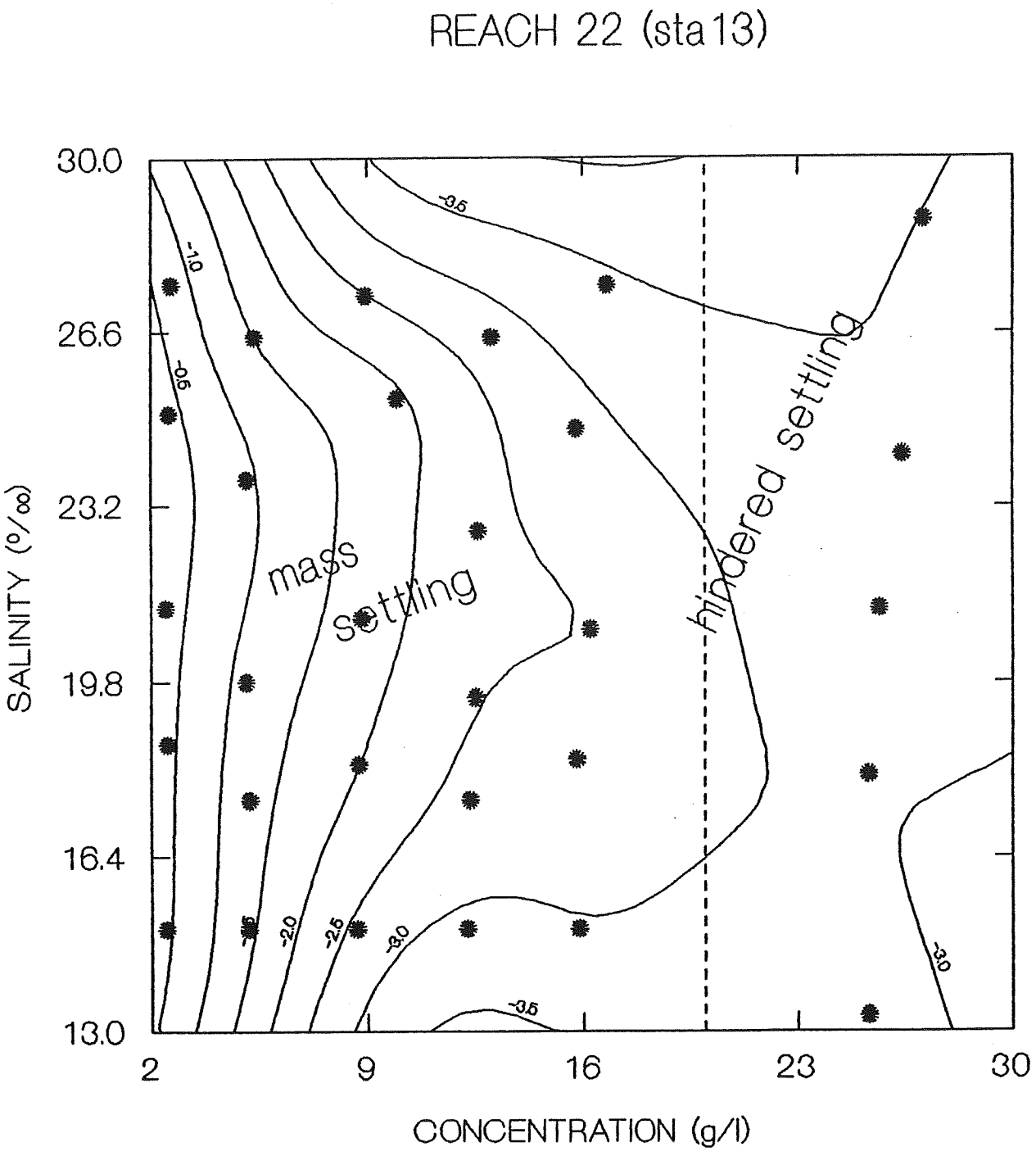


Figure 9. $K1_{lin}$ as a function of initial suspended sediment concentration and salinity for the Reach 22 sample.

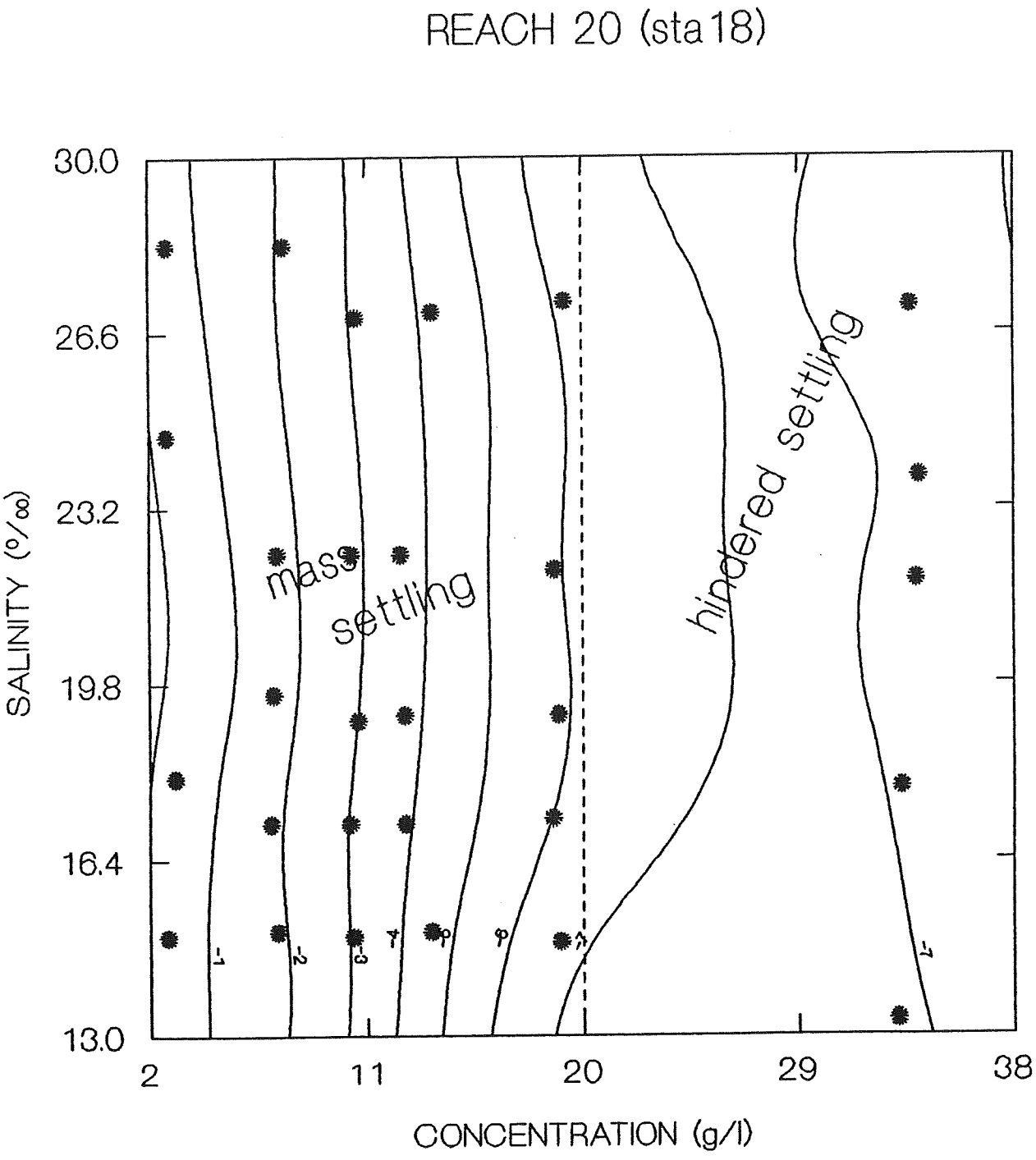
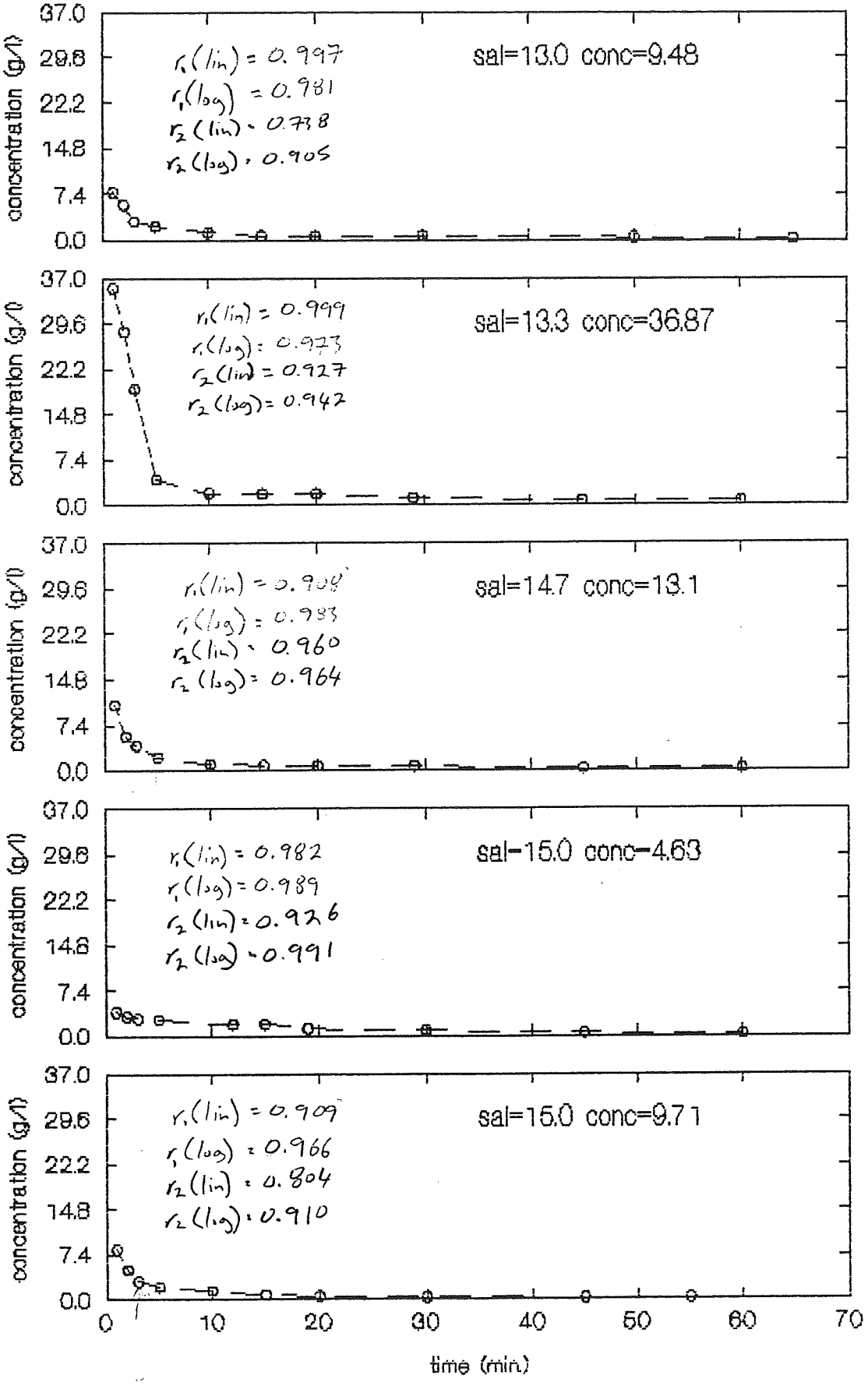


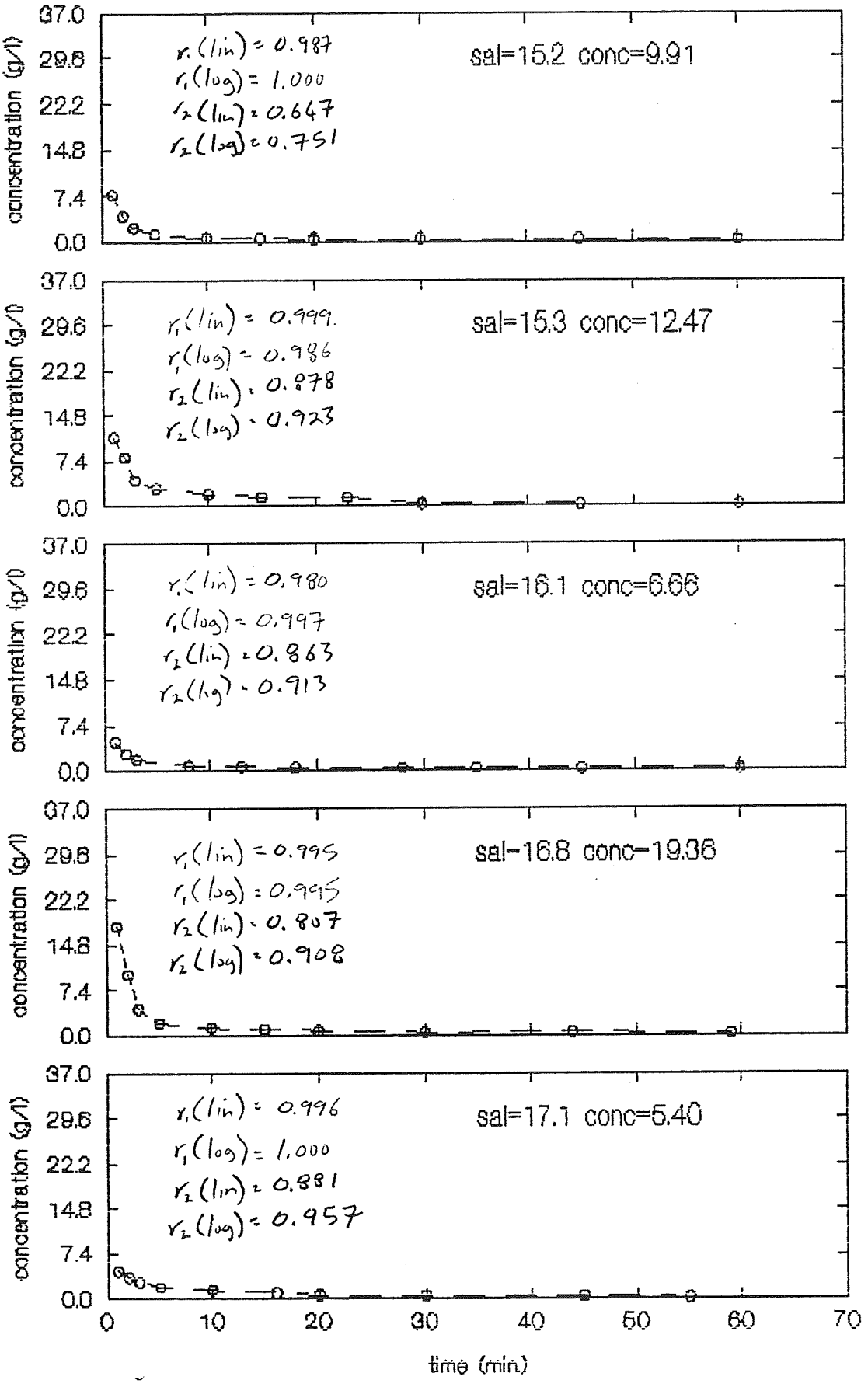
Figure 10. $K1_{lin}$ as a function of initial suspended sediment concentration and salinity for the Reach 20 sample.

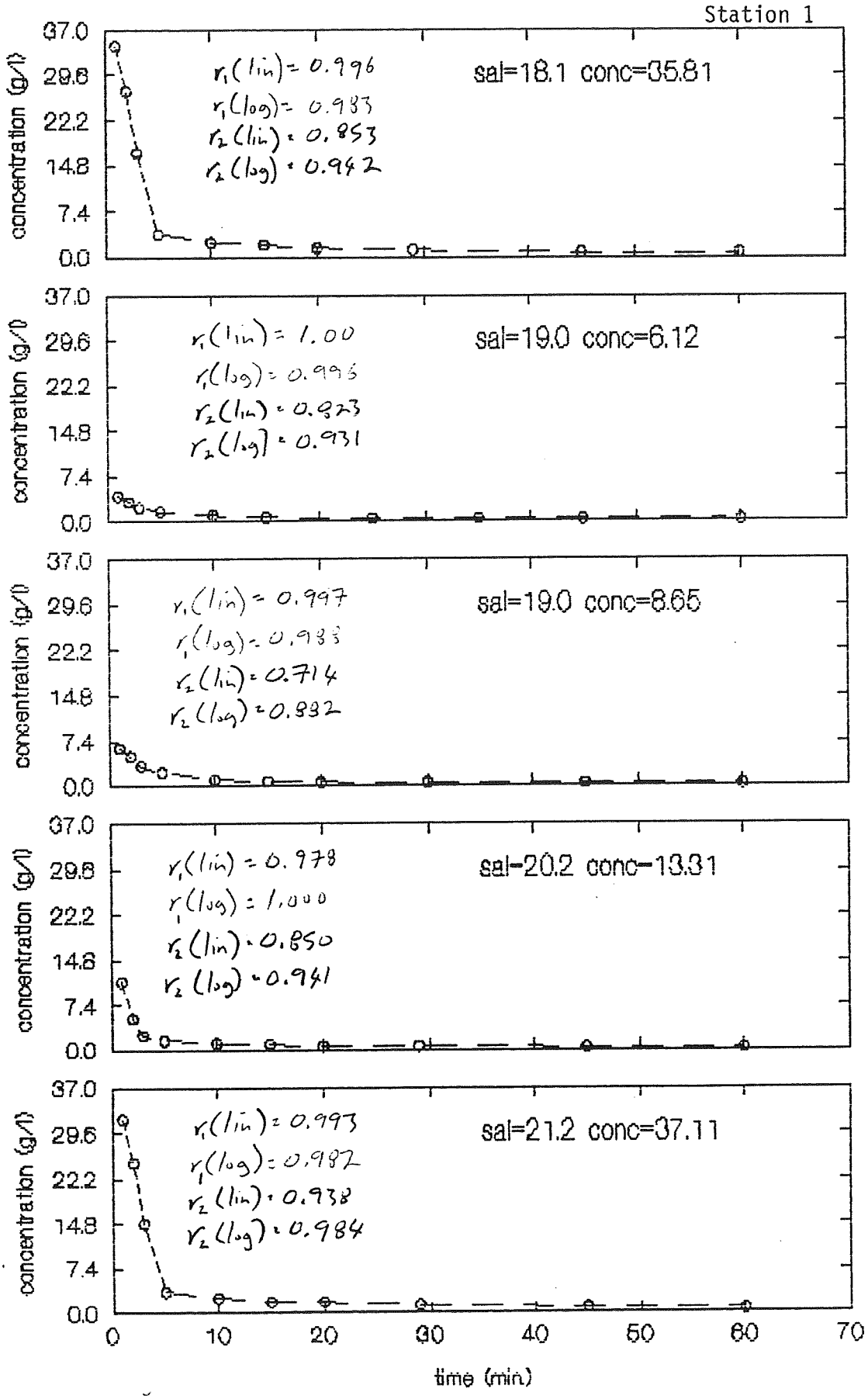
APPENDIX I

Station 1

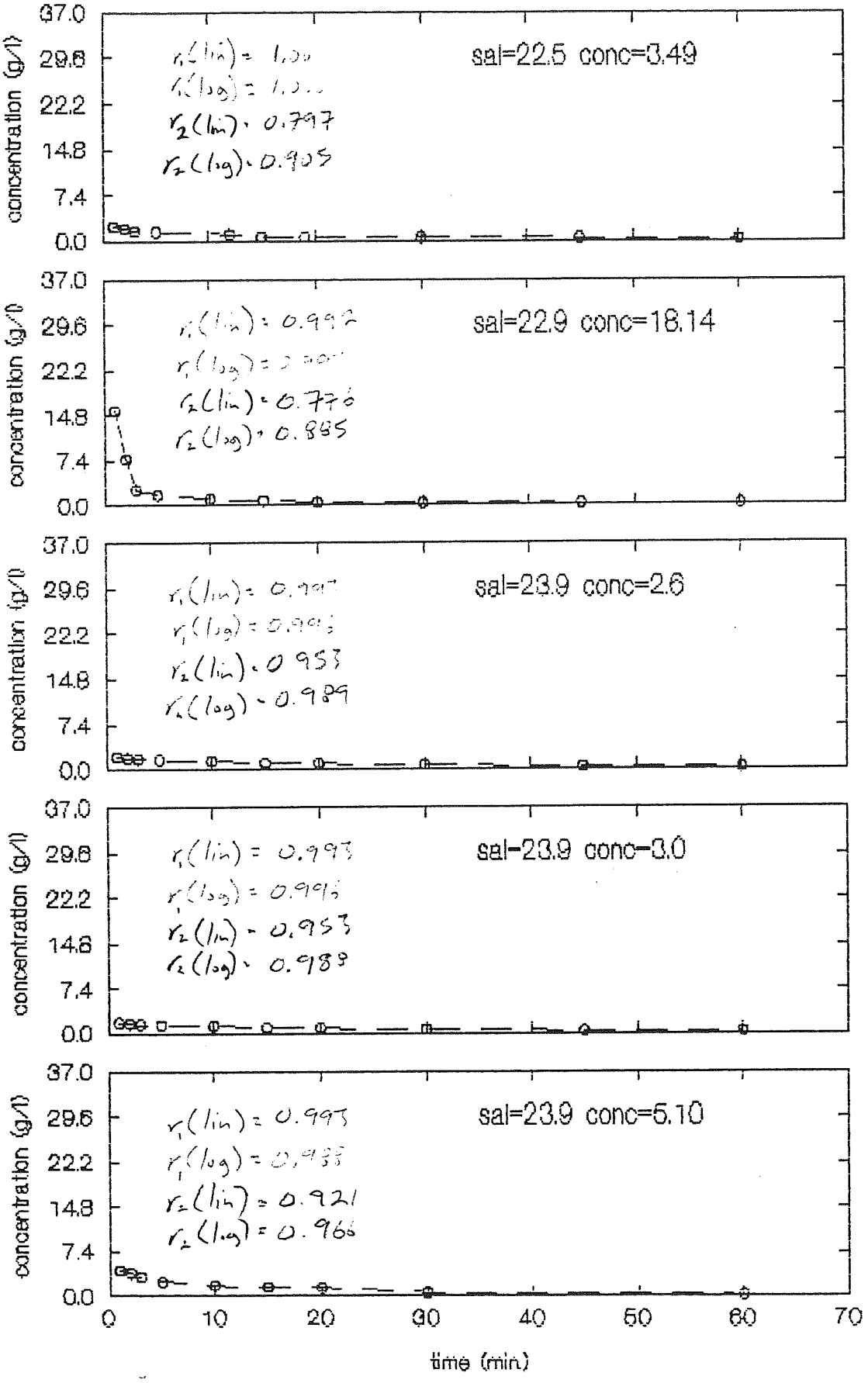

concentration (g/l)
37.0
29.6
22.2
14.8
7.4
0.0
r_1(lin) = 0.997
r_1(log) = 0.981
r_2(lin) = 0.738
r_2(log) = 0.905
sal=13.0 conc=9.48
r_1(lin) = 0.999
r_1(log) = 0.973
r_2(lin) = 0.927
r_2(log) = 0.942
sal=13.3 conc=36.87
r_1(lin) = 0.909
r_1(log) = 0.983
r_2(lin) = 0.960
r_2(log) = 0.964
sal=14.7 conc=13.1
r_1(lin) = 0.982
r_1(log) = 0.989
r_2(lin) = 0.926
r_2(log) = 0.991
sal=15.0 conc=4.63
r_1(lin) = 0.909
r_1(log) = 0.966
r_2(lin) = 0.804
r_2(log) = 0.910
sal=15.0 conc=9.71
0
10
20
30
40
50
60
70
time (min)

Station 1

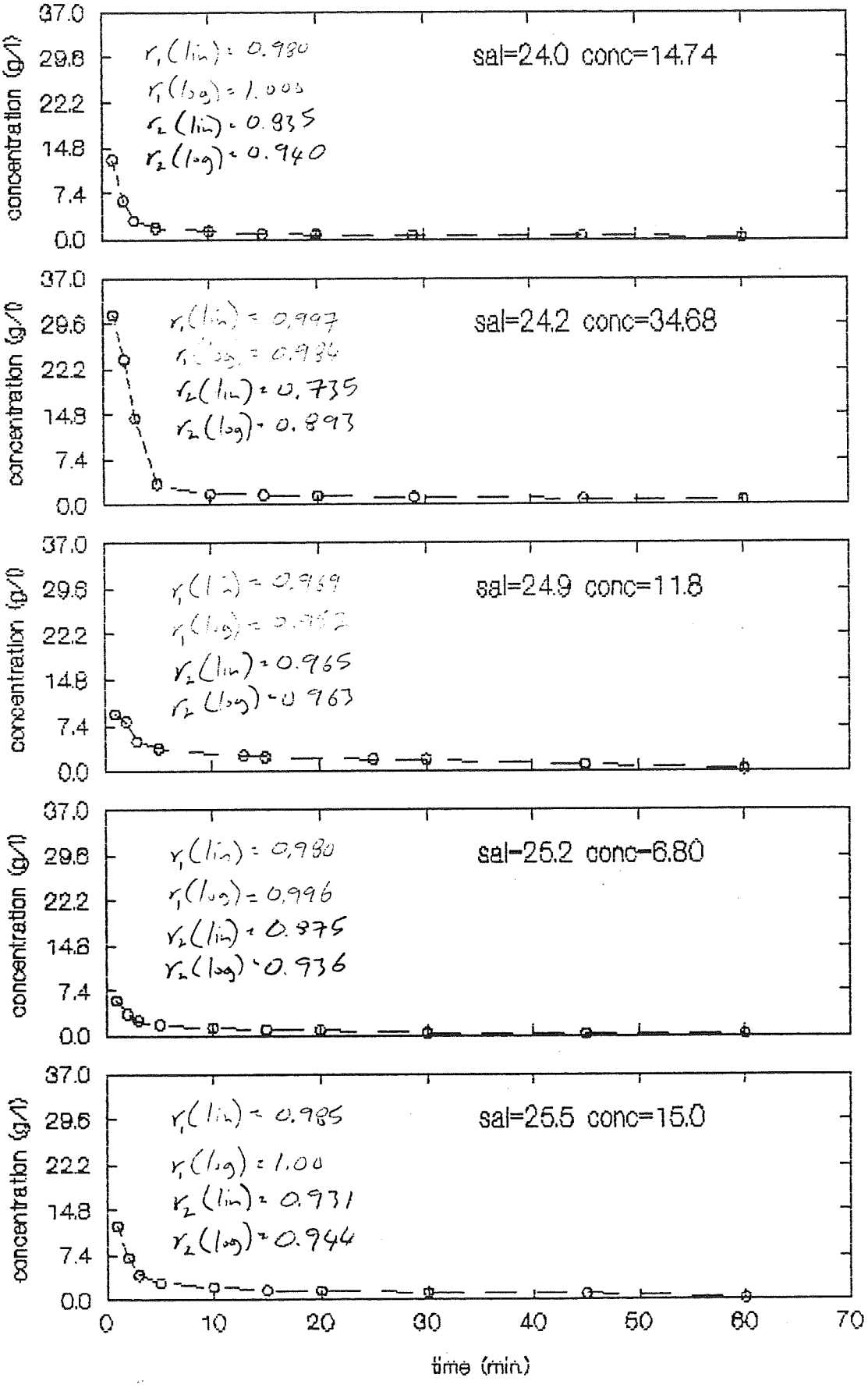

concentration (g/l)
37.0
29.6
22.2
14.8
7.4
0.0
r_1(lin) = 0.987
r_1(log) = 1.000
r_2(lin) = 0.647
r_2(log) = 0.751
sal=15.2 conc=9.91
r_1(lin) = 0.999
r_1(log) = 0.986
r_2(lin) = 0.878
r_2(log) = 0.923
sal=15.3 conc=12.47
r_1(lin) = 0.980
r_1(log) = 0.997
r_2(lin) = 0.863
r_2(log) = 0.913
sal=16.1 conc=6.66
r_1(lin) = 0.995
r_1(log) = 0.995
r_2(lin) = 0.807
r_2(log) = 0.908
sal=16.8 conc=19.36
r_1(lin) = 0.996
r_1(log) = 1.000
r_2(lin) = 0.881
r_2(log) = 0.957
sal=17.1 conc=5.40
0
10
20
30
40
50
60
70
time (min)


Station 1
concentration (g/l)
37.0
29.6
22.2
14.8
7.4
0.0
$r_1(lin) = 0.996$
$r_1(log) = 0.983$
$r_2(lin) = 0.853$
$r_2(log) = 0.942$
sal=18.1 conc=35.81
$r_1(lin) = 1.00$
$r_1(log) = 0.996$
$r_2(lin) = 0.823$
$r_2(log) = 0.931$
sal=19.0 conc=6.12
$r_1(lin) = 0.997$
$r_1(log) = 0.983$
$r_2(lin) = 0.714$
$r_2(log) = 0.932$
sal=19.0 conc=8.65
$r_1(lin) = 0.978$
$r_1(log) = 1.000$
$r_2(lin) = 0.850$
$r_2(log) = 0.941$
sal=20.2 conc=13.31
$r_1(lin) = 0.993$
$r_1(log) = 0.982$
$r_2(lin) = 0.938$
$r_2(log) = 0.984$
sal=21.2 conc=37.11
0
10
20
30
40
50
60
70
time (min)

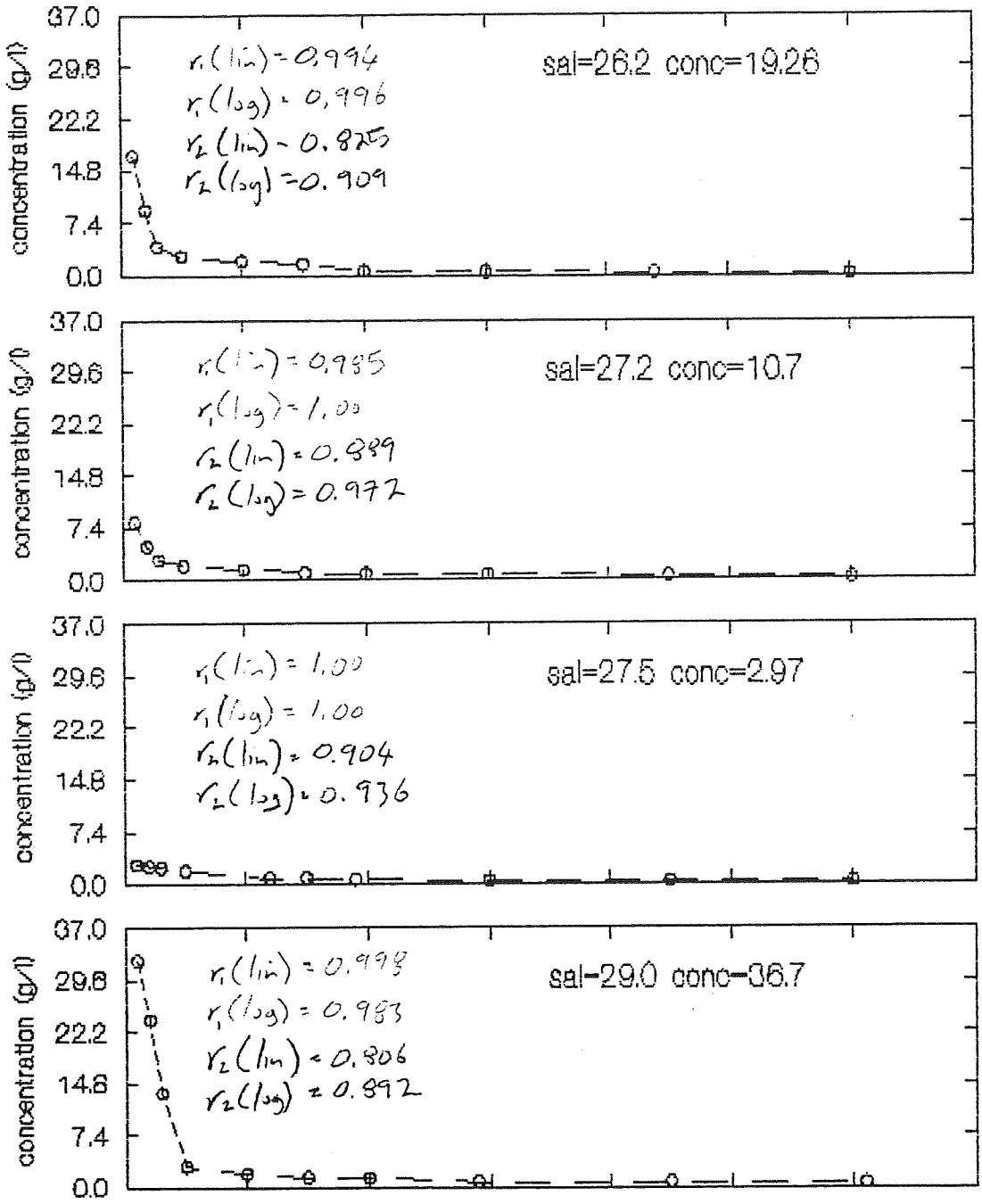
Station 1


concentration (g/l)
37.0
29.6
22.2
14.8
7.4
0.0
sal=22.5 conc=3.49
sal=22.9 conc=18.14
sal=23.9 conc=2.6
sal=23.9 conc=3.0
sal=23.9 conc=5.10
0
10
20
30
40
50
60
70
time (min)

Station 1


37.0
29.6
22.2
14.8
7.4
0.0
concentration (g/l)
r_1(lin) = 0.980
r_1(log) = 1.005
r_2(lin) = 0.935
r_2(log) = 0.940
sal=24.0 conc=14.74
r_1(lin) = 0.997
r_1(log) = 0.934
r_2(lin) = 0.735
r_2(log) = 0.893
sal=24.2 conc=34.68
r_1(lin) = 0.969
r_1(log) = 0.962
r_2(lin) = 0.965
r_2(log) = 0.963
sal=24.9 conc=11.8
r_1(lin) = 0.980
r_1(log) = 0.996
r_2(lin) = 0.875
r_2(log) = 0.936
sal=25.2 conc=6.80
r_1(lin) = 0.985
r_1(log) = 1.00
r_2(lin) = 0.931
r_2(log) = 0.944
sal=25.5 conc=15.0
0
10
20
30
40
50
60
70
time (min)

Station 1


37.0
29.6
22.2
14.8
7.4
0.0
concentration (g/l)
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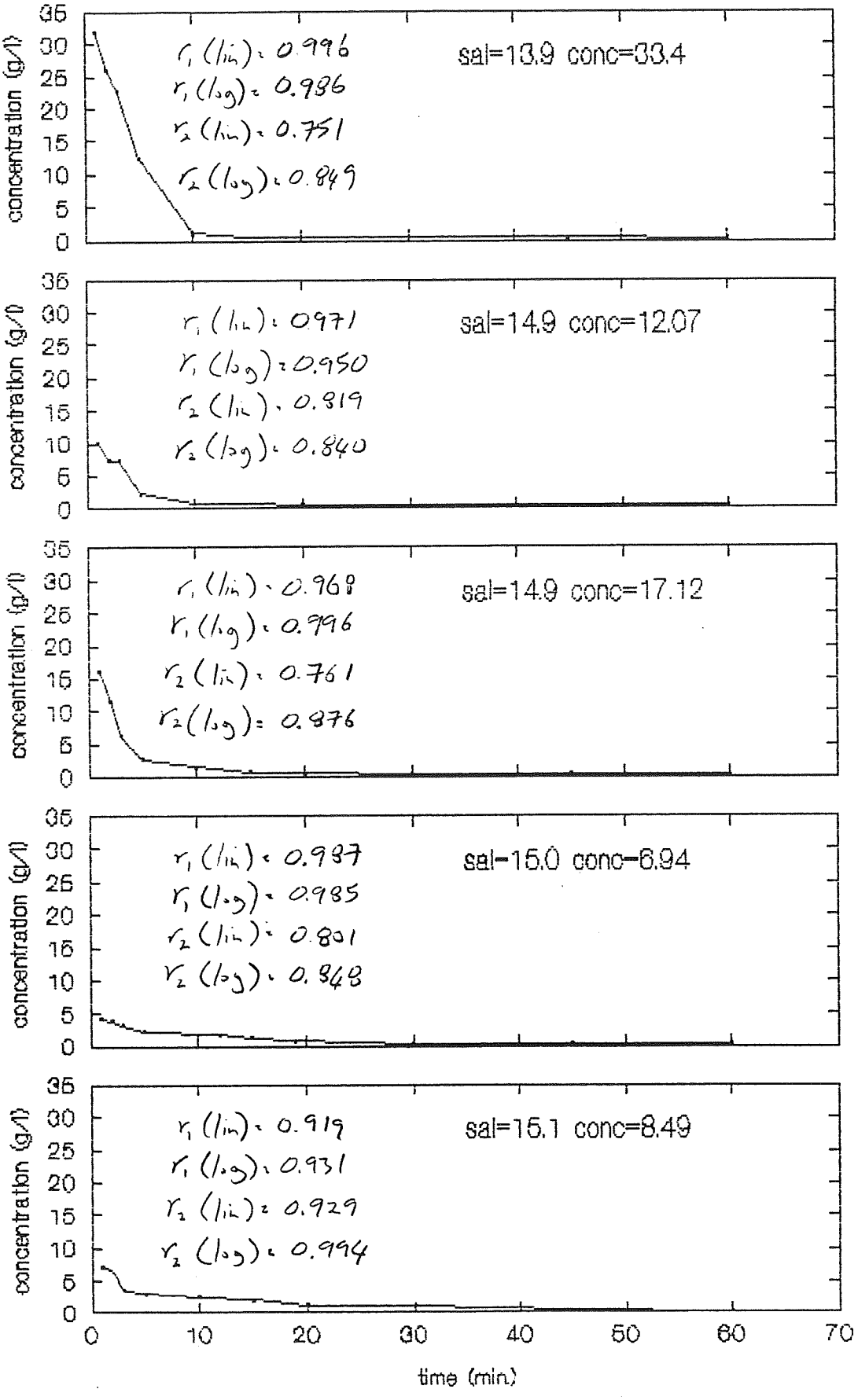
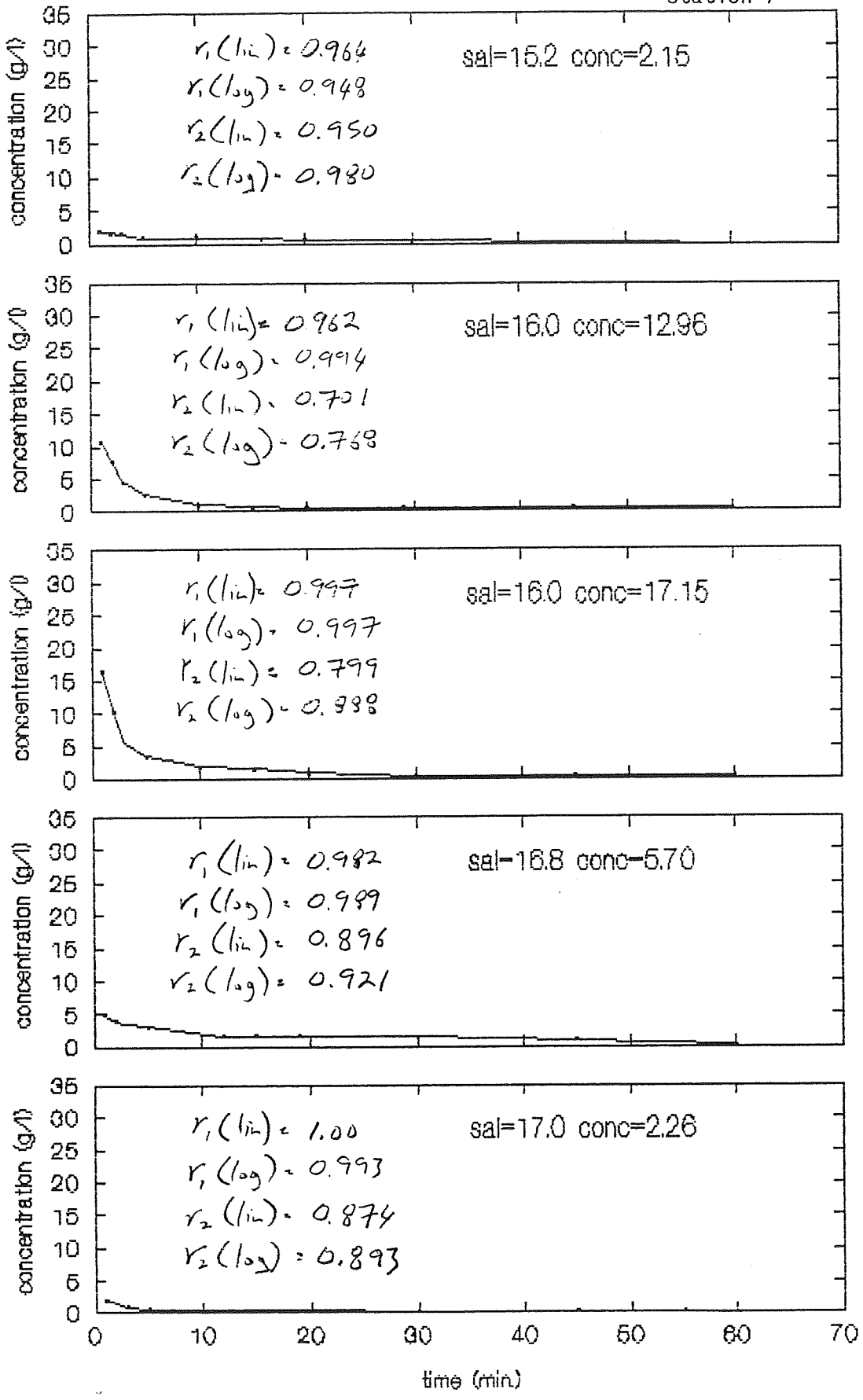
$r_1(log) = 0.996$
$r_2(lin) = 0.825$
$r_2(log) = 0.909$
sal=26.2 conc=19.26
37.0
29.6
22.2
14.8
7.4
0.0
concentration (g/l)
$r_1(lin) = 0.995$
$r_1(log) = 1.00$
$r_2(lin) = 0.889$
$r_2(log) = 0.972$
sal=27.2 conc=10.7
37.0
29.6
22.2
14.8
7.4
0.0
concentration (g/l)
$r_1(lin) = 1.00$
$r_1(log) = 1.00$
$r_2(lin) = 0.904$
$r_2(log) = 0.936$
sal=27.5 conc=2.97
37.0
29.6
22.2
14.8
7.4
0.0
concentration (g/l)
$r_1(lin) = 0.998$
$r_1(log) = 0.983$
$r_2(lin) = 0.806$
$r_2(log) = 0.892$
sal=29.0 conc=36.7

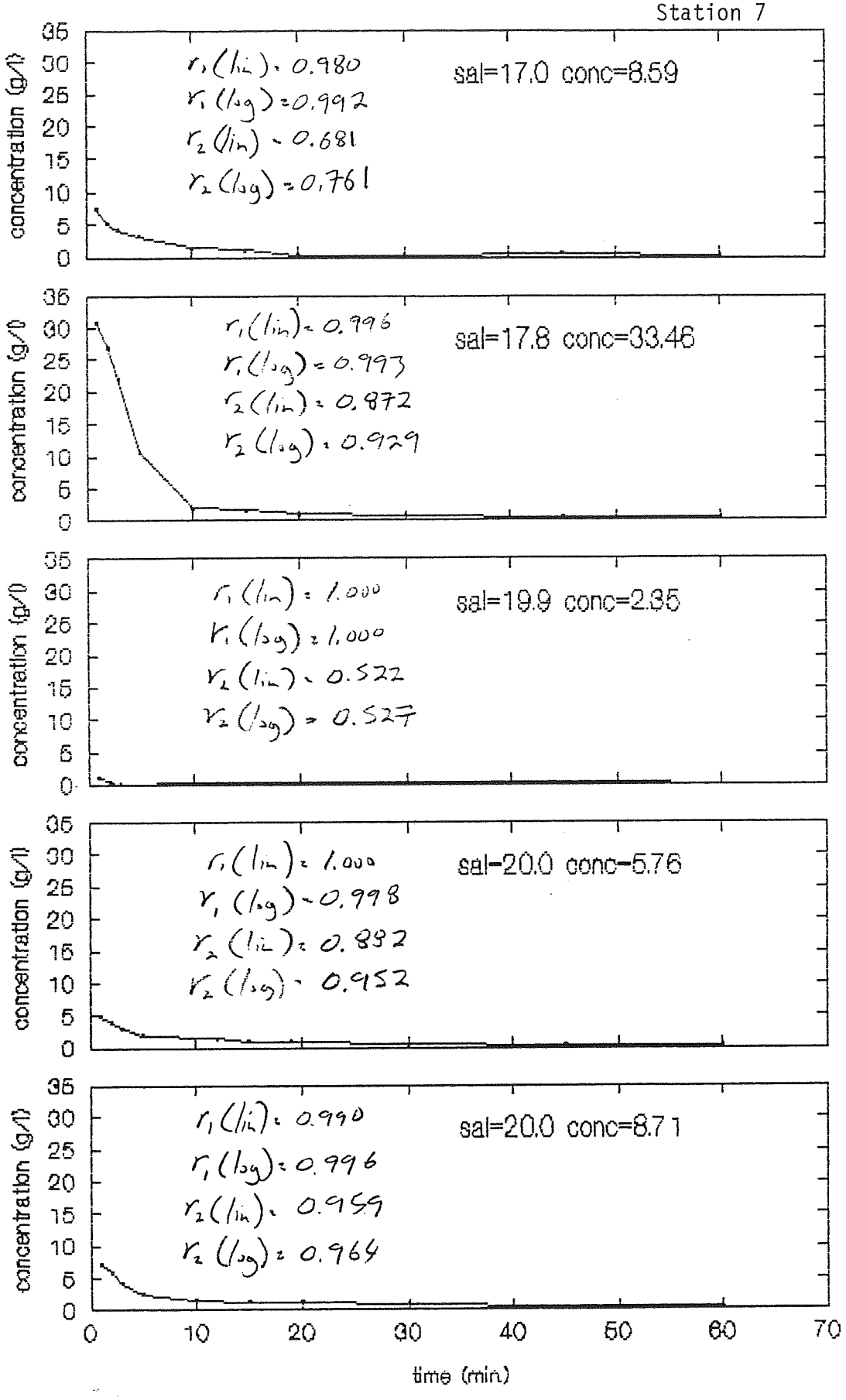
Station 7


concentration (g/l)
time (min.)
r1 (lin) = 0.996
r1 (log) = 0.986
r2 (lin) = 0.751
r2 (log) = 0.849
sal=13.9 conc=33.4
r1 (lin) = 0.971
r1 (log) = 0.950
r2 (lin) = 0.819
r2 (log) = 0.840
sal=14.9 conc=12.07
r1 (lin) = 0.968
r1 (log) = 0.996
r2 (lin) = 0.761
r2 (log) = 0.876
sal=14.9 conc=17.12
r1 (lin) = 0.987
r1 (log) = 0.985
r2 (lin) = 0.801
r2 (log) = 0.848
sal=15.0 conc=6.94
r1 (lin) = 0.919
r1 (log) = 0.931
r2 (lin) = 0.929
r2 (log) = 0.994
sal=15.1 conc=8.49

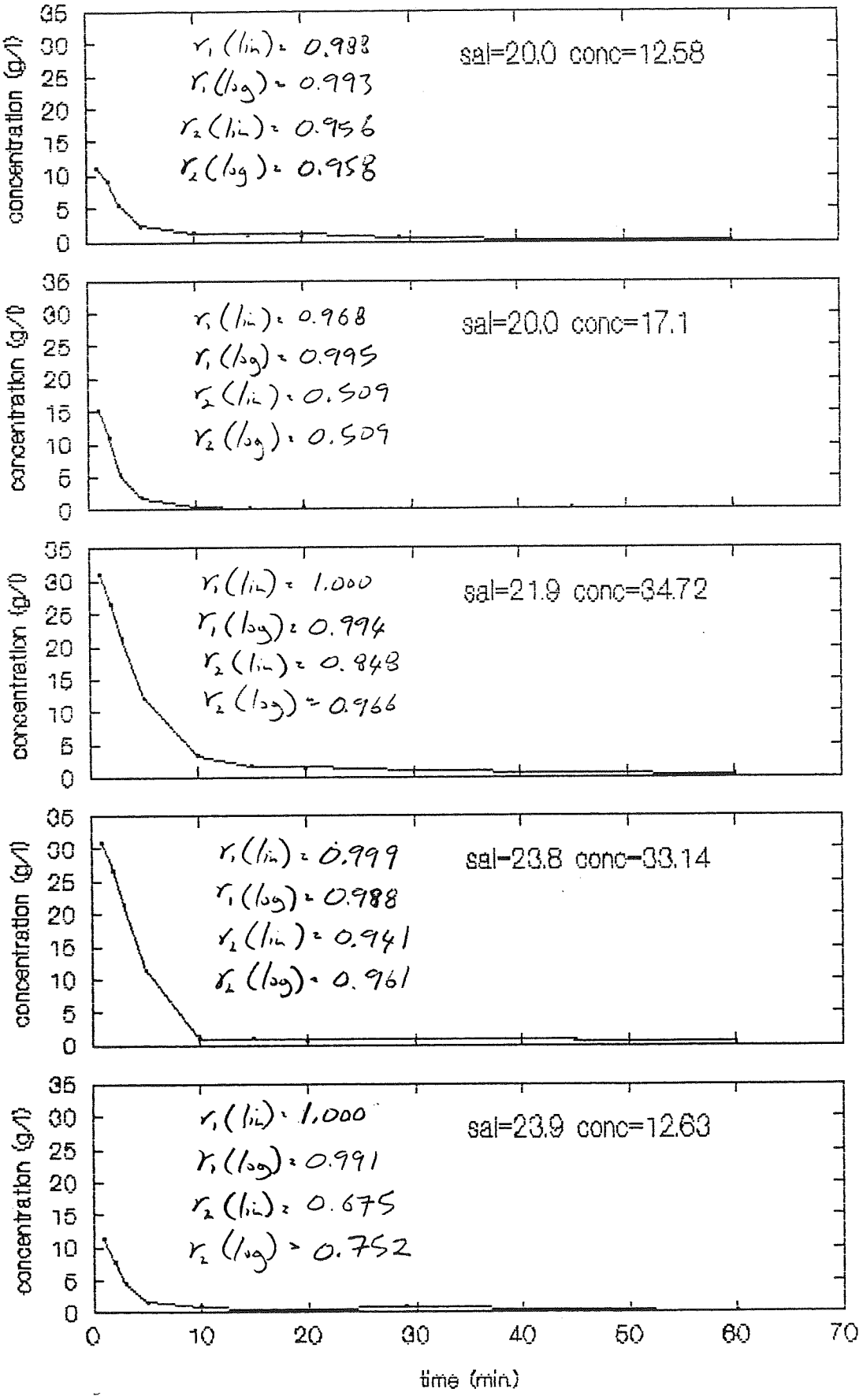
Station 7


concentration (g/l)
time (min)
r1(lin) = 0.964
r1(log) = 0.948
r2(lin) = 0.950
r2(log) = 0.980
sal=15.2 conc=2.15
r1(lin) = 0.962
r1(log) = 0.994
r2(lin) = 0.701
r2(log) = 0.768
sal=16.0 conc=12.96
r1(lin) = 0.997
r1(log) = 0.997
r2(lin) = 0.799
r2(log) = 0.988
sal=16.0 conc=17.15
r1(lin) = 0.982
r1(log) = 0.989
r2(lin) = 0.896
r2(log) = 0.921
sal=16.8 conc=5.70
r1(lin) = 1.00
r1(log) = 0.993
r2(lin) = 0.874
r2(log) = 0.893
sal=17.0 conc=2.26

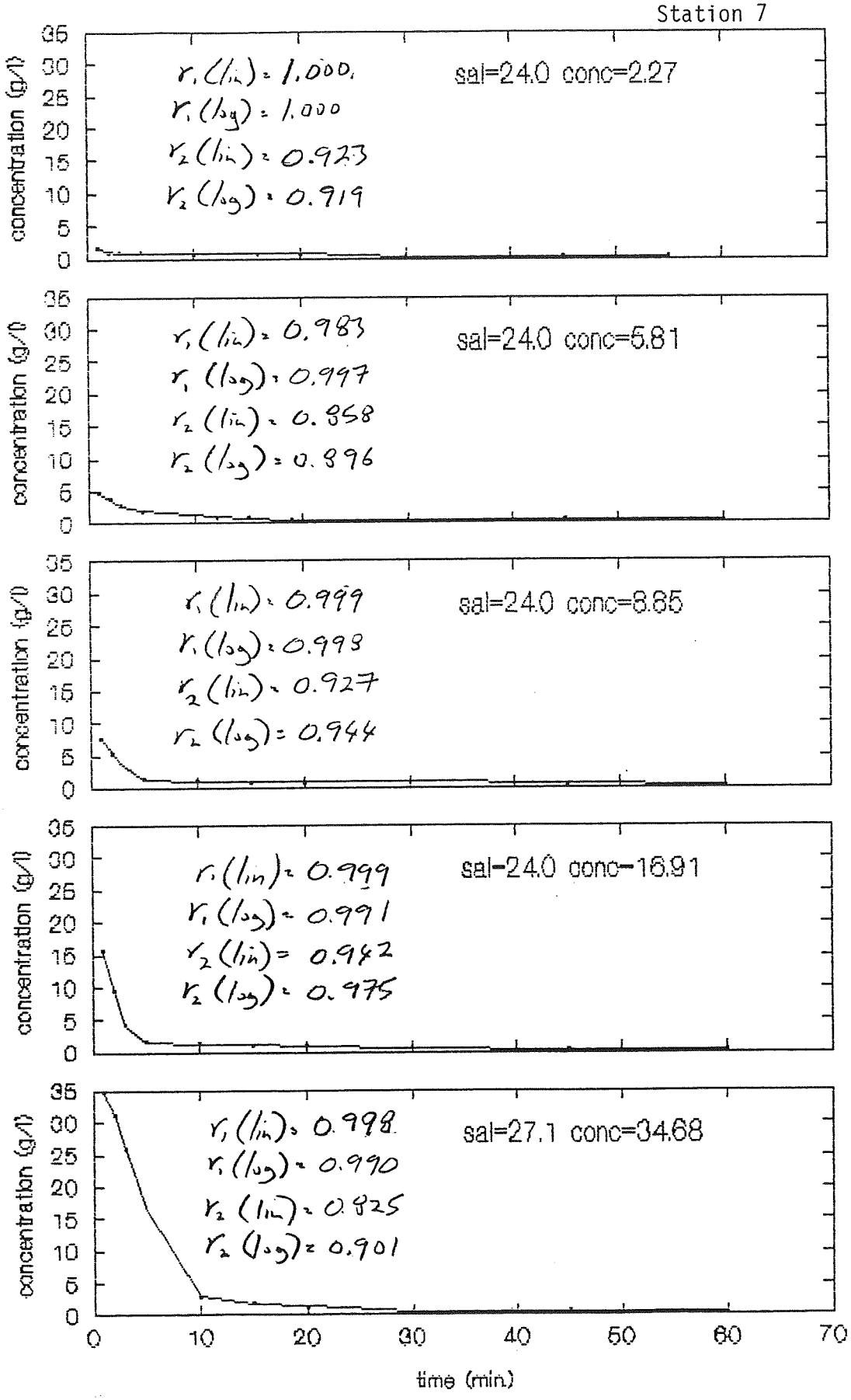
Station 7


concentration (g/l)
time (min)
r1(lin) = 0.980
r1(log) = 0.992
r2(lin) = 0.681
r2(log) = 0.761
sal=17.0 conc=8.59
r1(lin) = 0.996
r1(log) = 0.993
r2(lin) = 0.872
r2(log) = 0.929
sal=17.8 conc=33.46
r1(lin) = 1.000
r1(log) = 1.000
r2(lin) = 0.522
r2(log) = 0.527
sal=19.9 conc=2.35
r1(lin) = 1.000
r1(log) = 0.998
r2(lin) = 0.892
r2(log) = 0.952
sal=20.0 conc=5.76
r1(lin) = 0.990
r1(log) = 0.996
r2(lin) = 0.959
r2(log) = 0.964
sal=20.0 conc=8.71

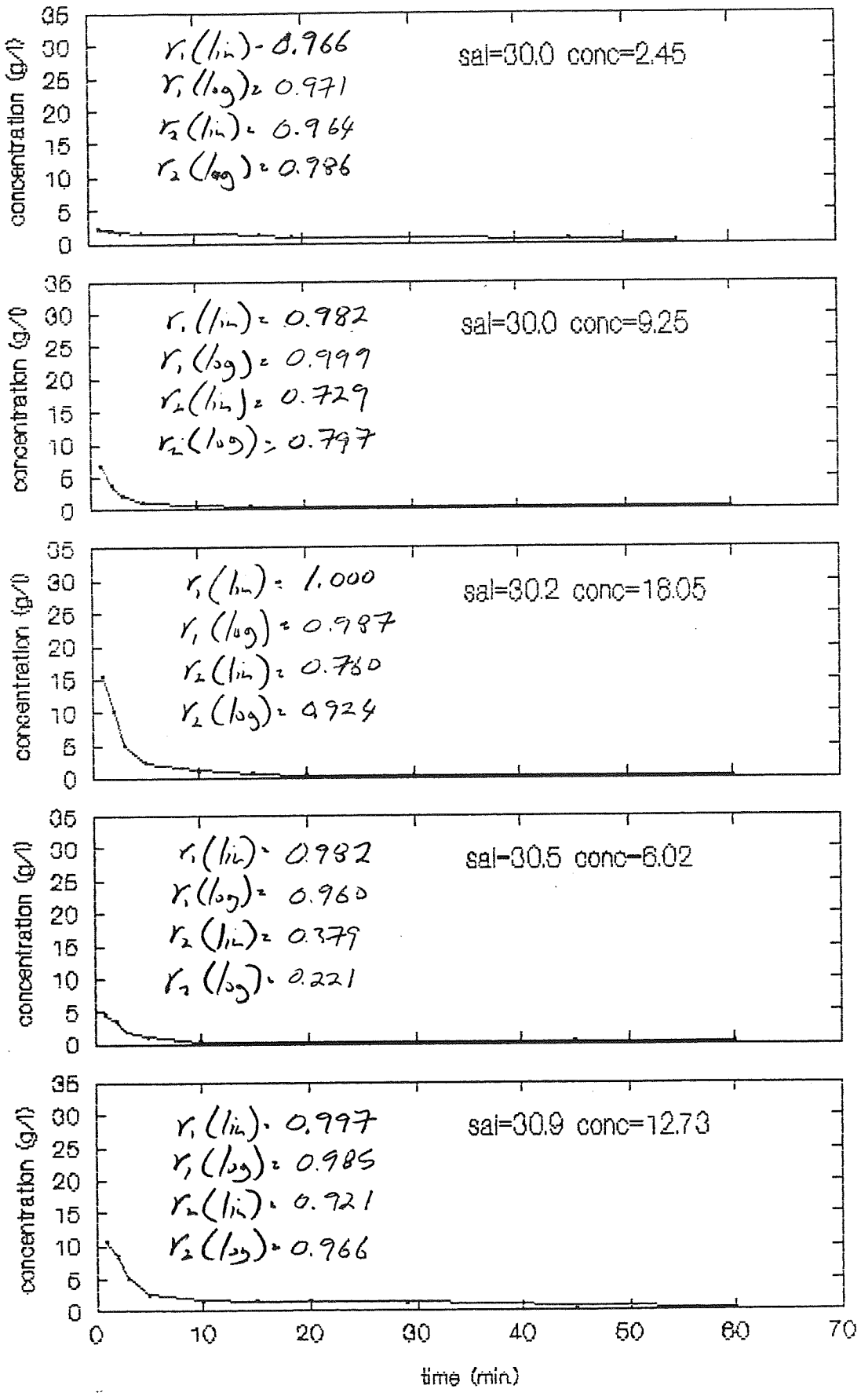
Station 7


concentration (g/l)
time (min)
r1 (lin) = 0.988
r1 (log) = 0.993
r2 (lin) = 0.956
r2 (log) = 0.958
sal=20.0 conc=12.58
r1 (lin) = 0.968
r1 (log) = 0.995
r2 (lin) = 0.509
r2 (log) = 0.509
sal=20.0 conc=17.1
r1 (lin) = 1.000
r1 (log) = 0.994
r2 (lin) = 0.848
r2 (log) = 0.966
sal=21.9 conc=34.72
r1 (lin) = 0.999
r1 (log) = 0.988
r2 (lin) = 0.941
r2 (log) = 0.961
sal=23.8 conc=33.14
r1 (lin) = 1.000
r1 (log) = 0.991
r2 (lin) = 0.675
r2 (log) = 0.752
sal=23.9 conc=12.63

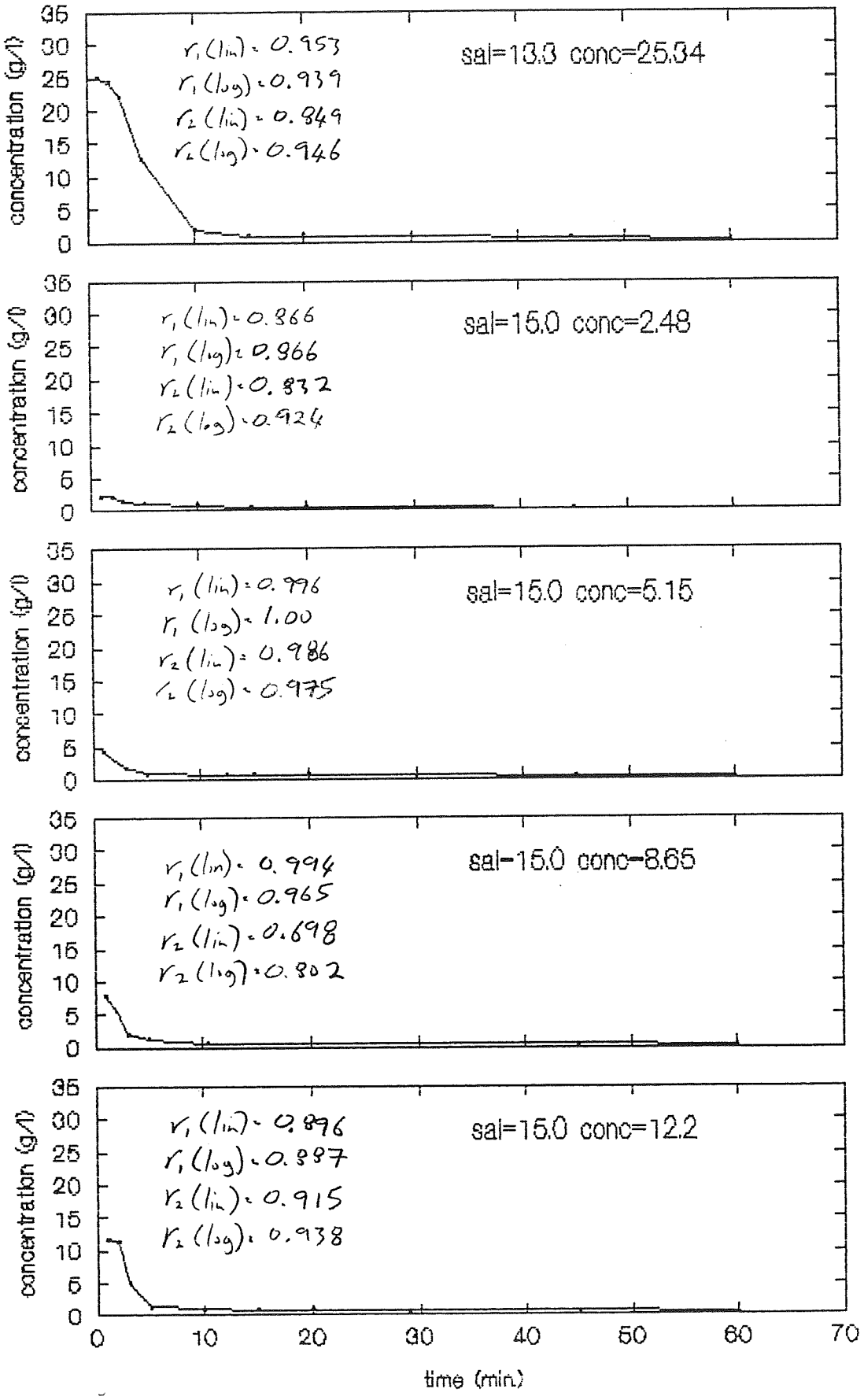
Station 7


concentration (g/l)
time (min.)
r_1 (lin) = 1.000
r_1 (log) = 1.000
r_2 (lin) = 0.923
r_2 (log) = 0.919
sal=24.0 conc=2.27
r_1 (lin) = 0.983
r_1 (log) = 0.997
r_2 (lin) = 0.858
r_2 (log) = 0.896
sal=24.0 conc=5.81
r_1 (lin) = 0.999
r_1 (log) = 0.998
r_2 (lin) = 0.927
r_2 (log) = 0.944
sal=24.0 conc=8.85
r_1 (lin) = 0.999
r_1 (log) = 0.991
r_2 (lin) = 0.942
r_2 (log) = 0.975
sal=24.0 conc=16.91
r_1 (lin) = 0.998
r_1 (log) = 0.990
r_2 (lin) = 0.825
r_2 (log) = 0.901
sal=27.1 conc=34.68

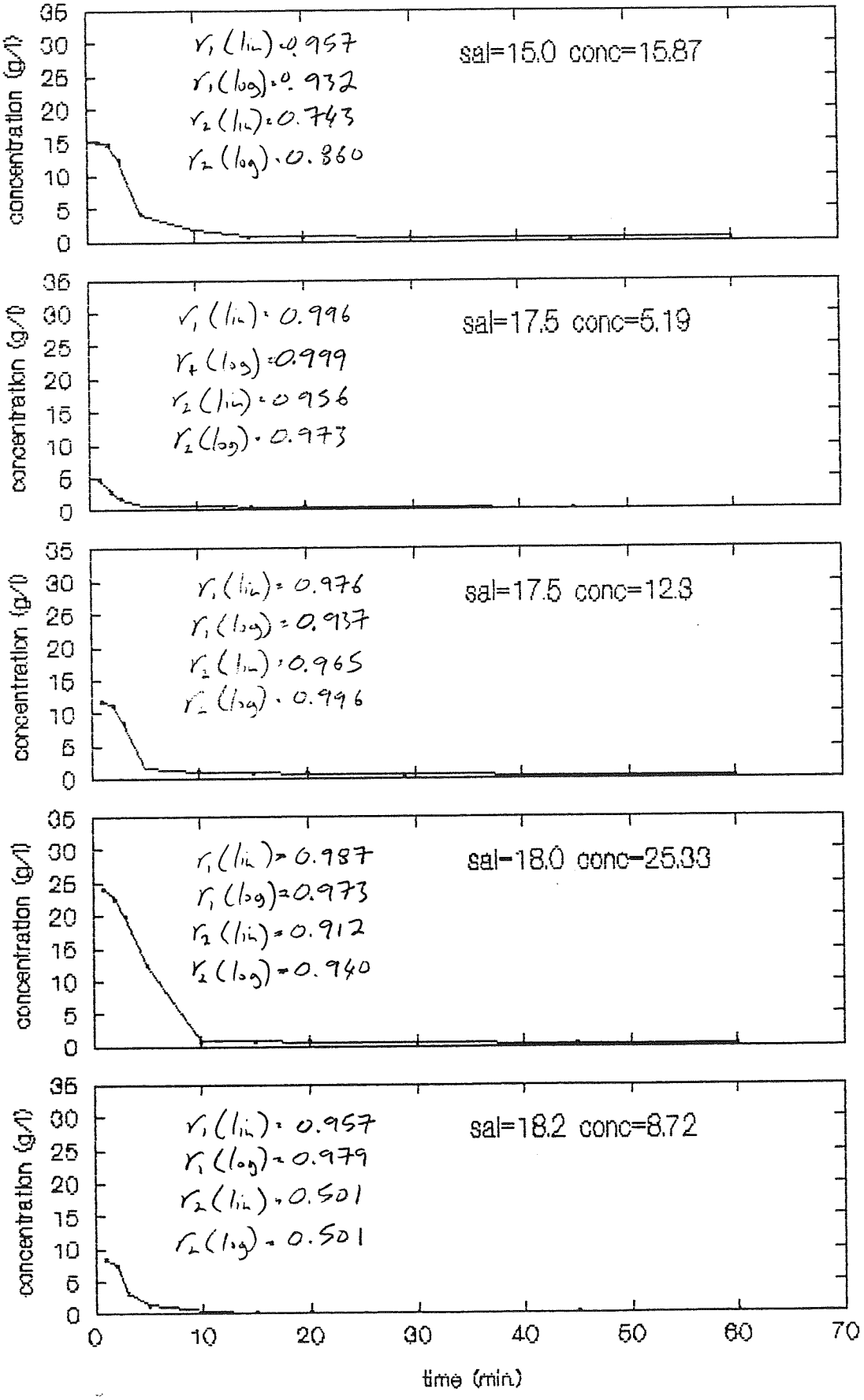
Station 7


concentration (g/l)
time (min)
r_1(lin)= 0.966
r_1(log)= 0.971
r_2(lin)= 0.964
r_2(log)= 0.986
sal=30.0 conc=2.45
r_1(lin)= 0.982
r_1(log)= 0.999
r_2(lin)= 0.729
r_2(log)= 0.797
sal=30.0 conc=9.25
r_1(lin)= 1.000
r_1(log)= 0.987
r_2(lin)= 0.780
r_2(log)= 0.924
sal=30.2 conc=18.05
r_1(lin)= 0.982
r_1(log)= 0.960
r_2(lin)= 0.379
r_2(log)= 0.221
sal=30.5 conc=6.02
r_1(lin)= 0.997
r_1(log)= 0.985
r_2(lin)= 0.921
r_2(log)= 0.966
sal=30.9 conc=12.73

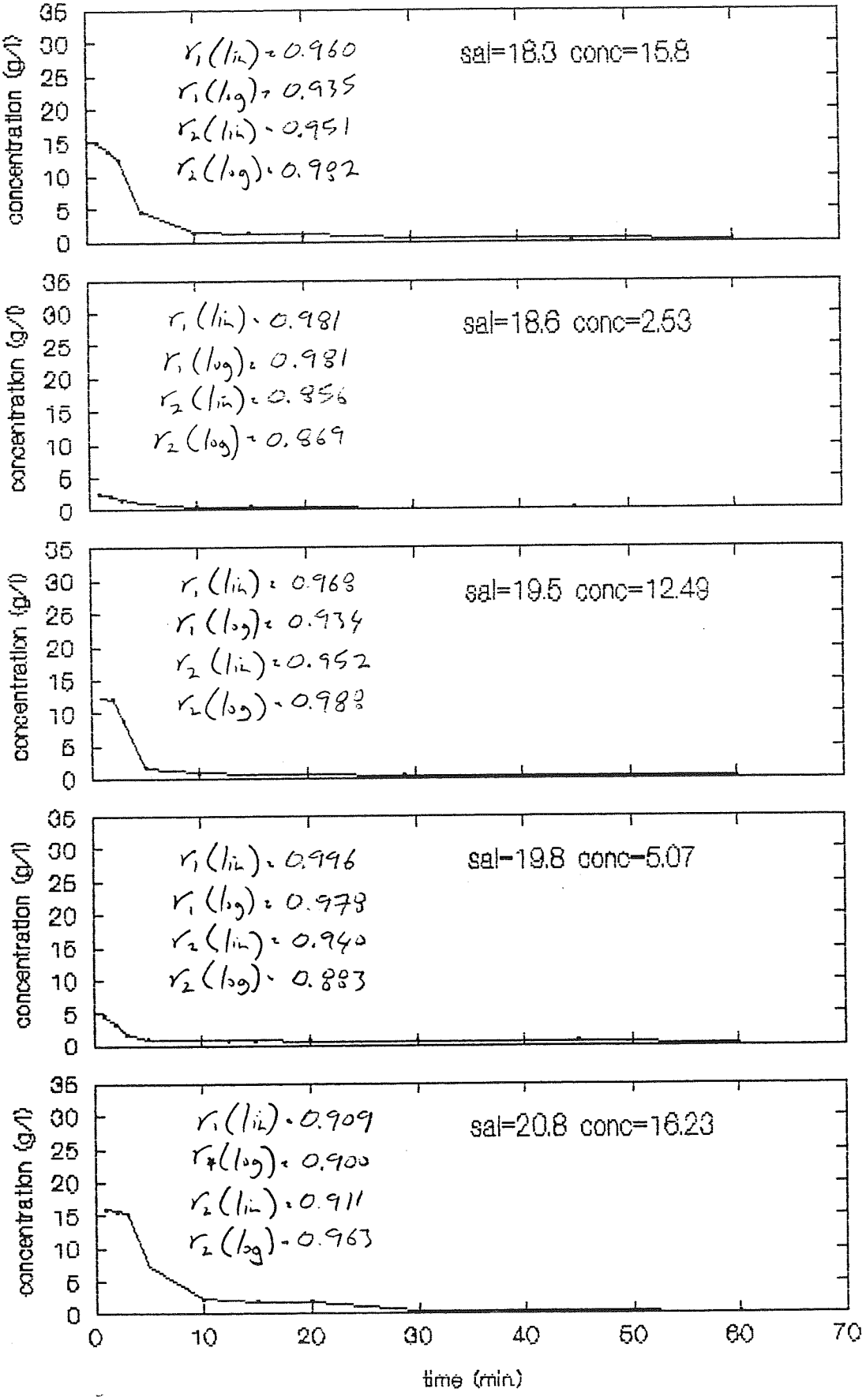
Station 13


concentration (g/l)
time (min)
sal=13.3 conc=25.34
r1 (lin) = 0.953
r1 (log) = 0.939
r2 (lin) = 0.849
r2 (log) = 0.946
sal=15.0 conc=2.48
r1 (lin) = 0.866
r1 (log) = 0.966
r2 (lin) = 0.832
r2 (log) = 0.924
sal=15.0 conc=5.15
r1 (lin) = 0.996
r1 (log) = 1.00
r2 (lin) = 0.986
r2 (log) = 0.975
sal=15.0 conc=8.65
r1 (lin) = 0.994
r1 (log) = 0.965
r2 (lin) = 0.698
r2 (log) = 0.802
sal=15.0 conc=12.2
r1 (lin) = 0.896
r1 (log) = 0.887
r2 (lin) = 0.915
r2 (log) = 0.938

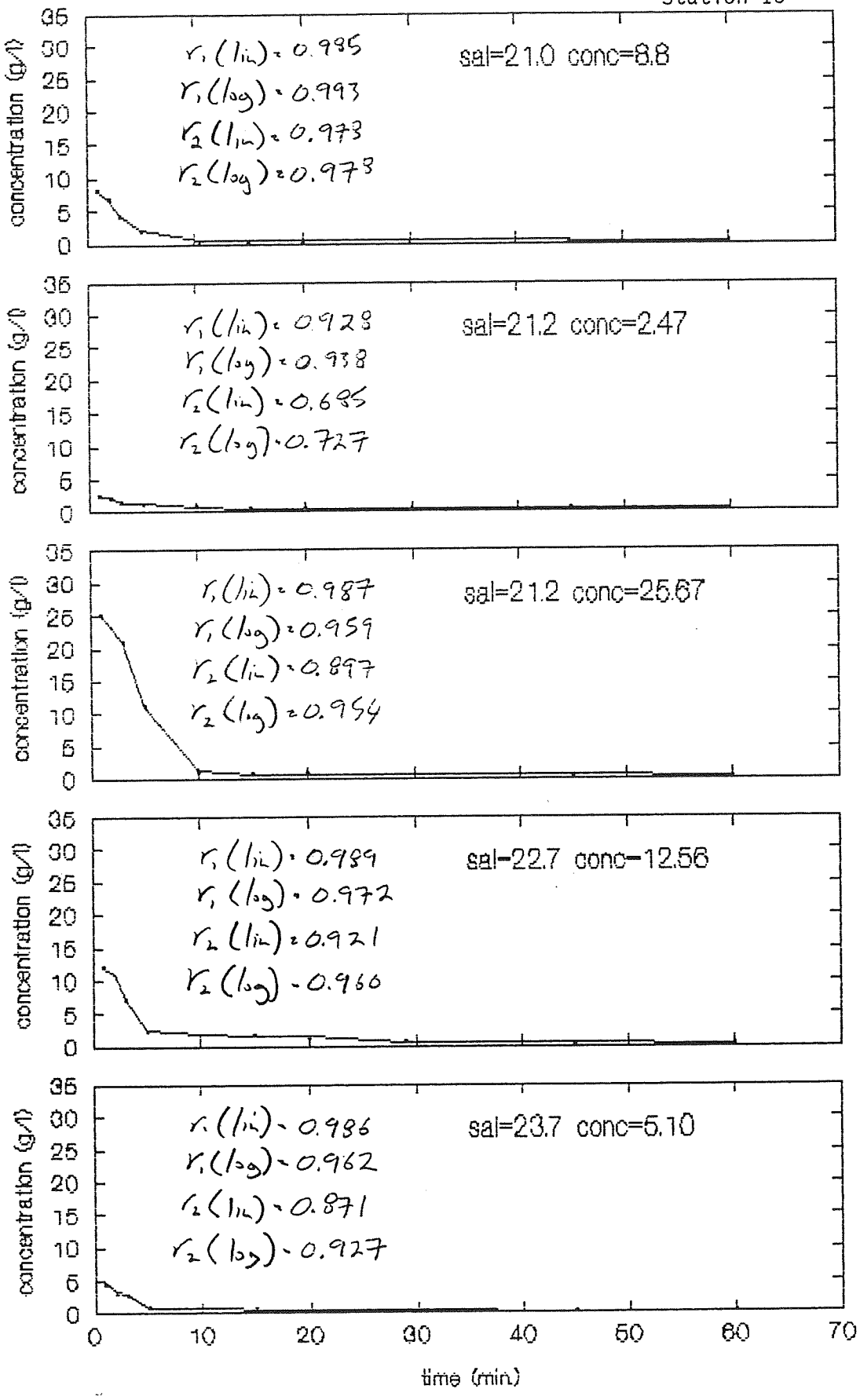
Station 13


concentration (g/l)
time (min)
r1 (lin) = 0.957
r1 (log) = 0.932
r2 (lin) = 0.743
r2 (log) = 0.860
sal=15.0 conc=15.87
r1 (lin) = 0.996
r1 (log) = 0.999
r2 (lin) = 0.956
r2 (log) = 0.973
sal=17.5 conc=5.19
r1 (lin) = 0.976
r1 (log) = 0.937
r2 (lin) = 0.965
r2 (log) = 0.996
sal=17.5 conc=12.3
r1 (lin) = 0.987
r1 (log) = 0.973
r2 (lin) = 0.912
r2 (log) = 0.940
sal=18.0 conc=25.33
r1 (lin) = 0.957
r1 (log) = 0.979
r2 (lin) = 0.501
r2 (log) = 0.501
sal=18.2 conc=8.72

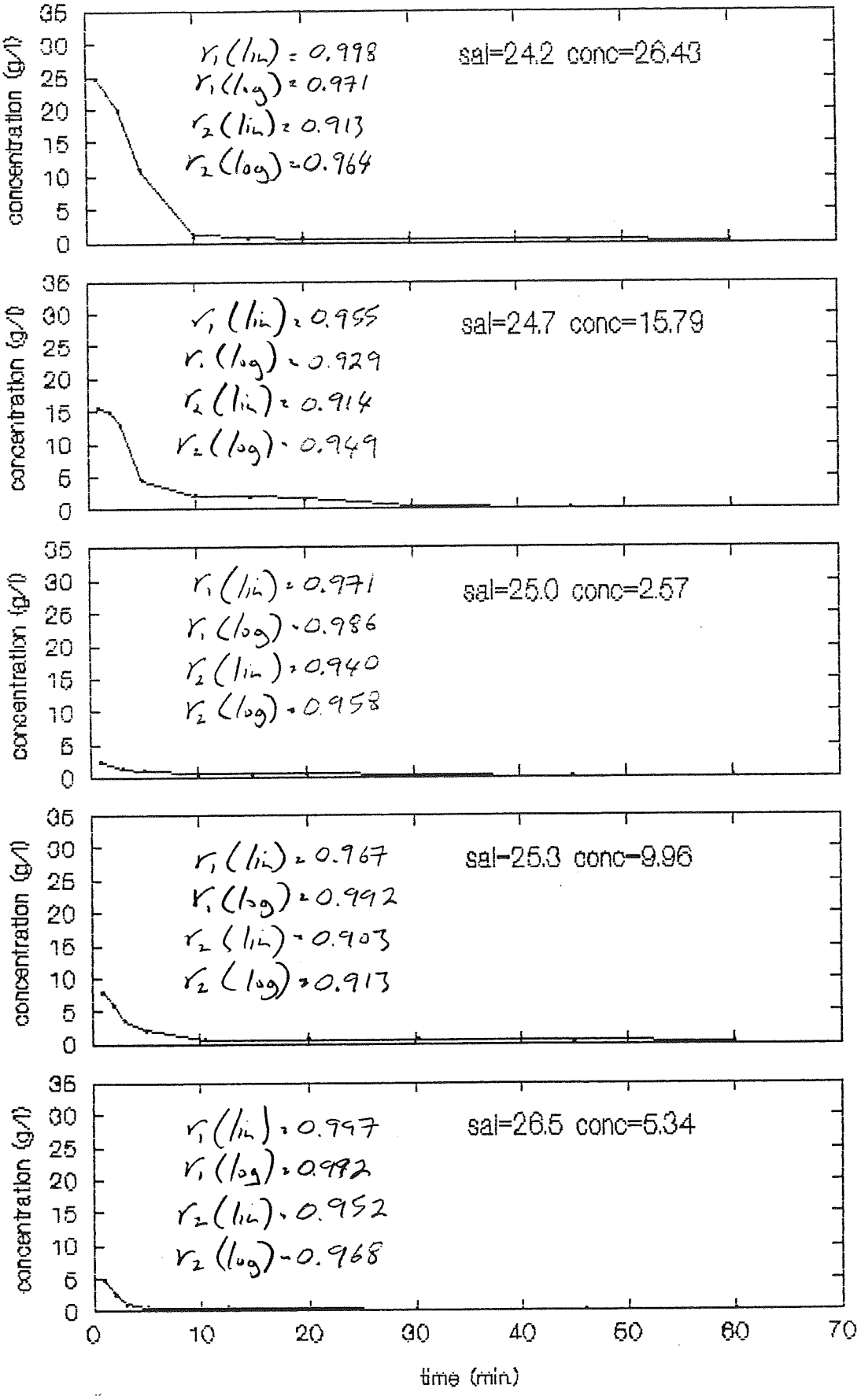
Station 13


concentration (g/l)
time (min)
r1(lin) = 0.960
r1(log) = 0.935
r2(lin) = 0.951
r2(log) = 0.982
sal=18.3 conc=15.8
r1(lin) = 0.981
r1(log) = 0.981
r2(lin) = 0.956
r2(log) = 0.869
sal=18.6 conc=2.53
r1(lin) = 0.968
r1(log) = 0.934
r2(lin) = 0.952
r2(log) = 0.982
sal=19.5 conc=12.49
r1(lin) = 0.996
r1(log) = 0.978
r2(lin) = 0.940
r2(log) = 0.883
sal=19.8 conc=5.07
r1(lin) = 0.909
r1(log) = 0.900
r2(lin) = 0.911
r2(log) = 0.963
sal=20.8 conc=16.23

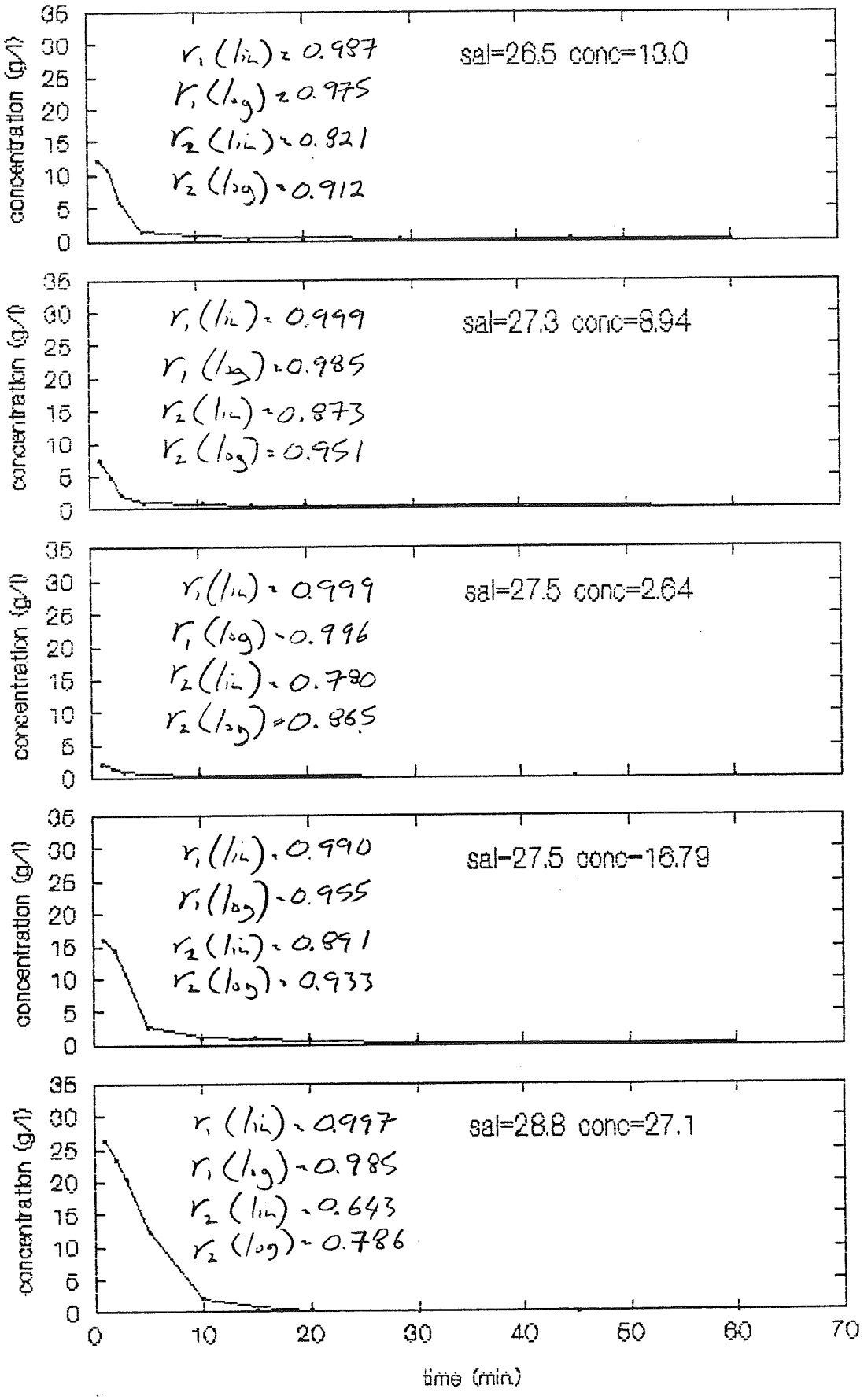
Station 13


concentration (g/l)
time (min)
r1(lin) = 0.985
r1(log) = 0.993
r2(lin) = 0.973
r2(log) = 0.973
sal=21.0 conc=8.8
r1(lin) = 0.928
r1(log) = 0.938
r2(lin) = 0.685
r2(log) = 0.727
sal=21.2 conc=2.47
r1(lin) = 0.987
r1(log) = 0.959
r2(lin) = 0.897
r2(log) = 0.954
sal=21.2 conc=25.67
r1(lin) = 0.989
r1(log) = 0.972
r2(lin) = 0.921
r2(log) = 0.960
sal=22.7 conc=12.56
r1(lin) = 0.986
r1(log) = 0.962
r2(lin) = 0.871
r2(log) = 0.927
sal=23.7 conc=5.10

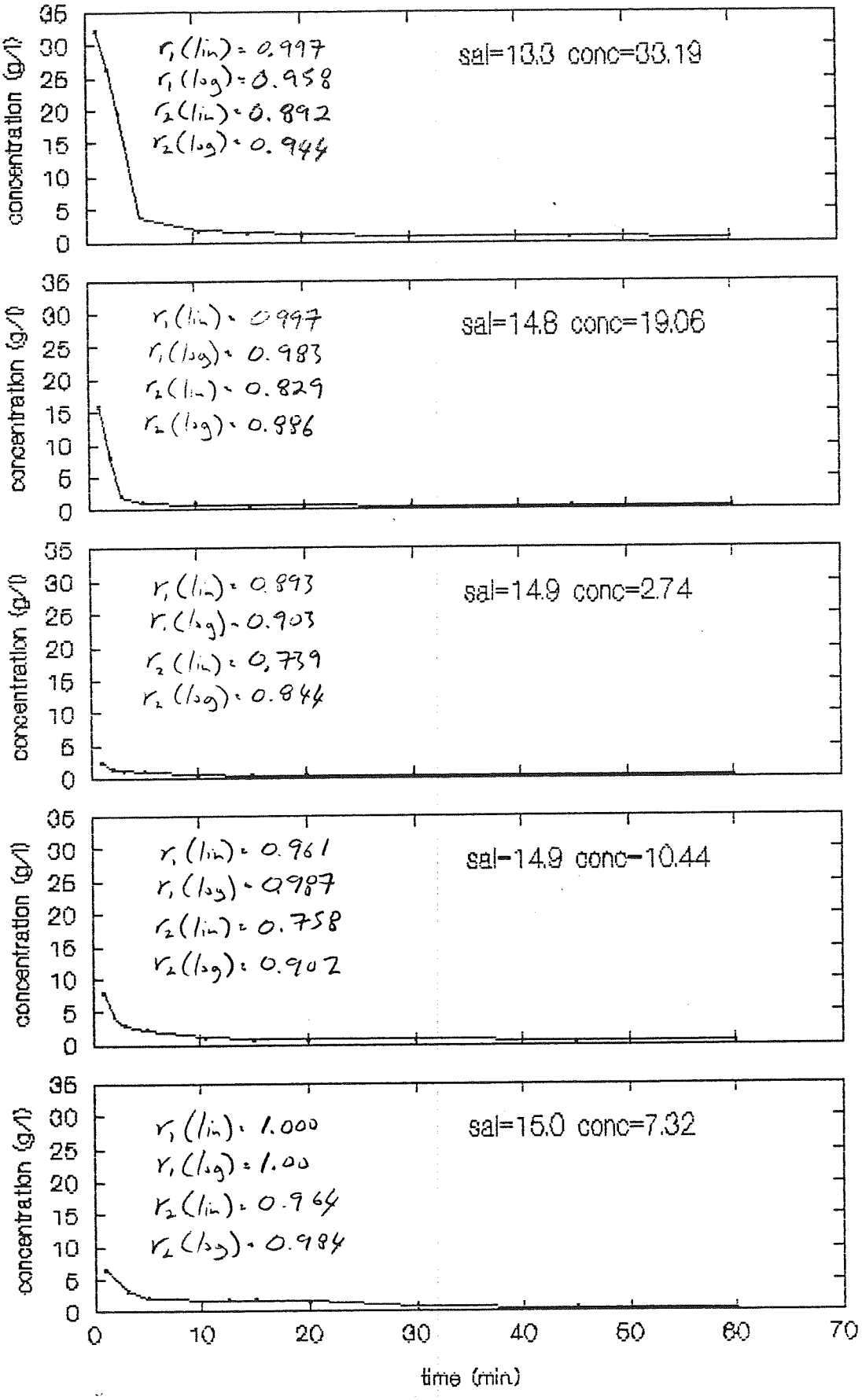
Station 13


concentration (g/l)
time (min)
r_1 (lin) = 0.998
r_1 (log) = 0.971
r_2 (lin) = 0.913
r_2 (log) = 0.964
sal=24.2 conc=26.43
r_1 (lin) = 0.955
r_1 (log) = 0.929
r_2 (lin) = 0.914
r_2 (log) = 0.949
sal=24.7 conc=15.79
r_1 (lin) = 0.971
r_1 (log) = 0.986
r_2 (lin) = 0.940
r_2 (log) = 0.958
sal=25.0 conc=2.57
r_1 (lin) = 0.967
r_1 (log) = 0.992
r_2 (lin) = 0.903
r_2 (log) = 0.913
sal=25.3 conc=9.96
r_1 (lin) = 0.997
r_1 (log) = 0.992
r_2 (lin) = 0.952
r_2 (log) = 0.968
sal=26.5 conc=5.34

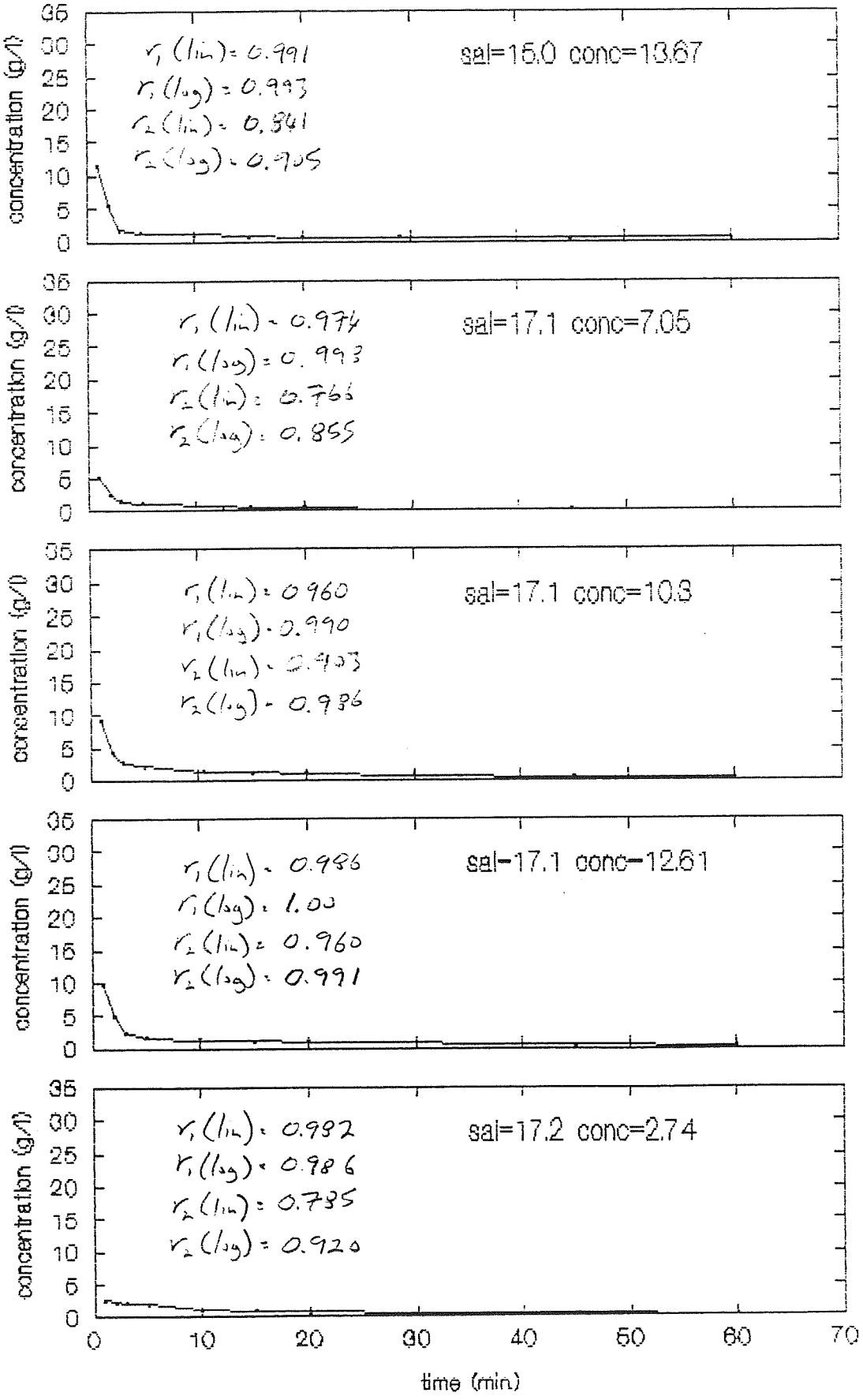
Station 13


concentration (g/l)
time (min)
r_1 (lin) = 0.987
r_1 (log) = 0.975
r_2 (lin) = 0.821
r_2 (log) = 0.912
sal=26.5 conc=13.0
r_1 (lin) = 0.999
r_1 (log) = 0.985
r_2 (lin) = 0.873
r_2 (log) = 0.951
sal=27.3 conc=8.94
r_1 (lin) = 0.999
r_1 (log) = 0.996
r_2 (lin) = 0.780
r_2 (log) = 0.865
sal=27.5 conc=2.64
r_1 (lin) = 0.990
r_1 (log) = 0.955
r_2 (lin) = 0.891
r_2 (log) = 0.933
sal=27.5 conc=16.79
r_1 (lin) = 0.997
r_1 (log) = 0.985
r_2 (lin) = 0.643
r_2 (log) = 0.786
sal=28.8 conc=27.1

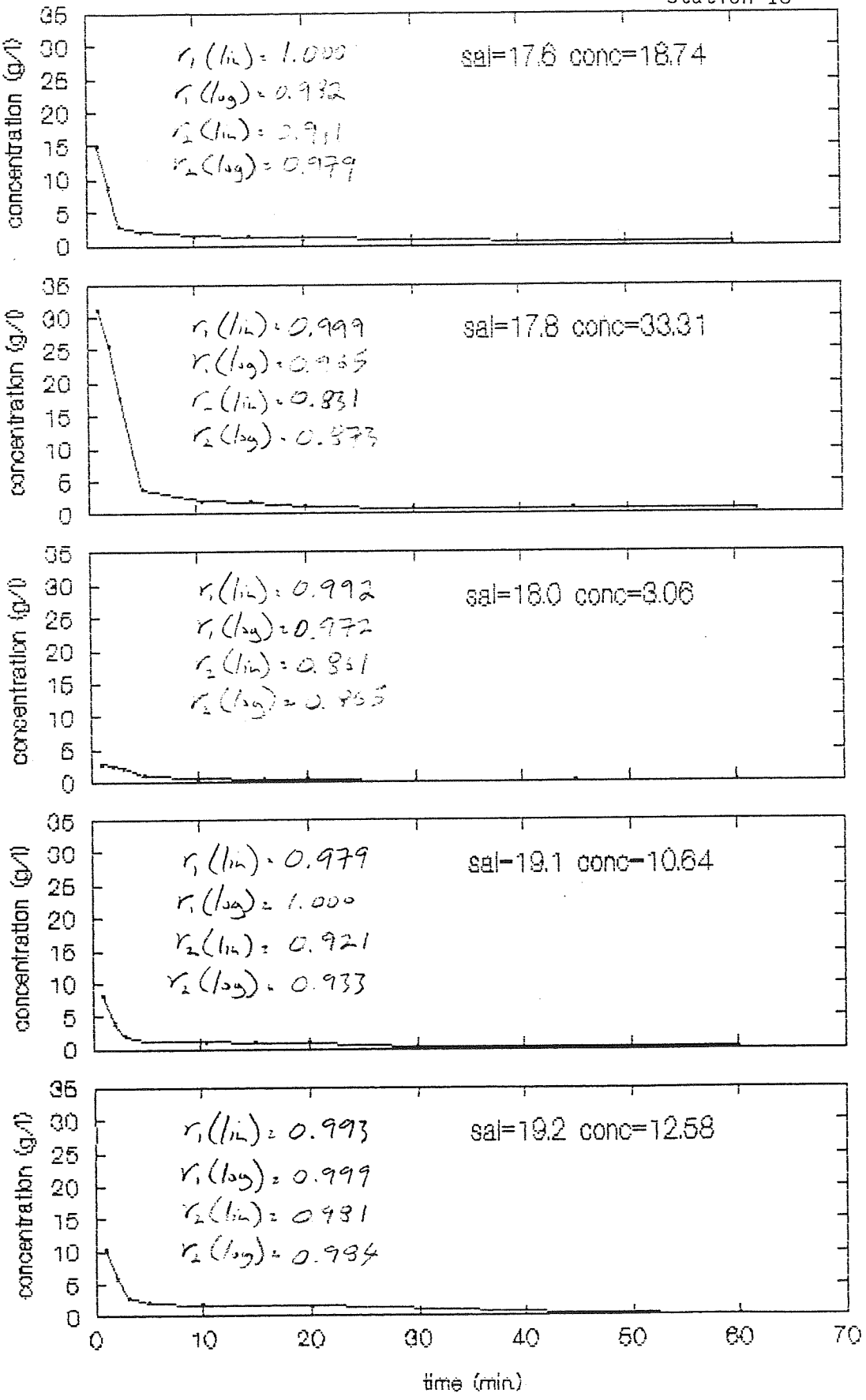
Station 18


concentration (g/l)
time (min)
r1(lin) = 0.997
r1(log) = 0.958
r2(lin) = 0.892
r2(log) = 0.944
sal=13.3 conc=33.19
r1(lin) = 0.997
r1(log) = 0.983
r2(lin) = 0.829
r2(log) = 0.986
sal=14.8 conc=19.06
r1(lin) = 0.893
r1(log) = 0.903
r2(lin) = 0.739
r2(log) = 0.844
sal=14.9 conc=2.74
r1(lin) = 0.961
r1(log) = 0.987
r2(lin) = 0.758
r2(log) = 0.902
sal=14.9 conc=10.44
r1(lin) = 1.000
r1(log) = 1.00
r2(lin) = 0.964
r2(log) = 0.984
sal=15.0 conc=7.32

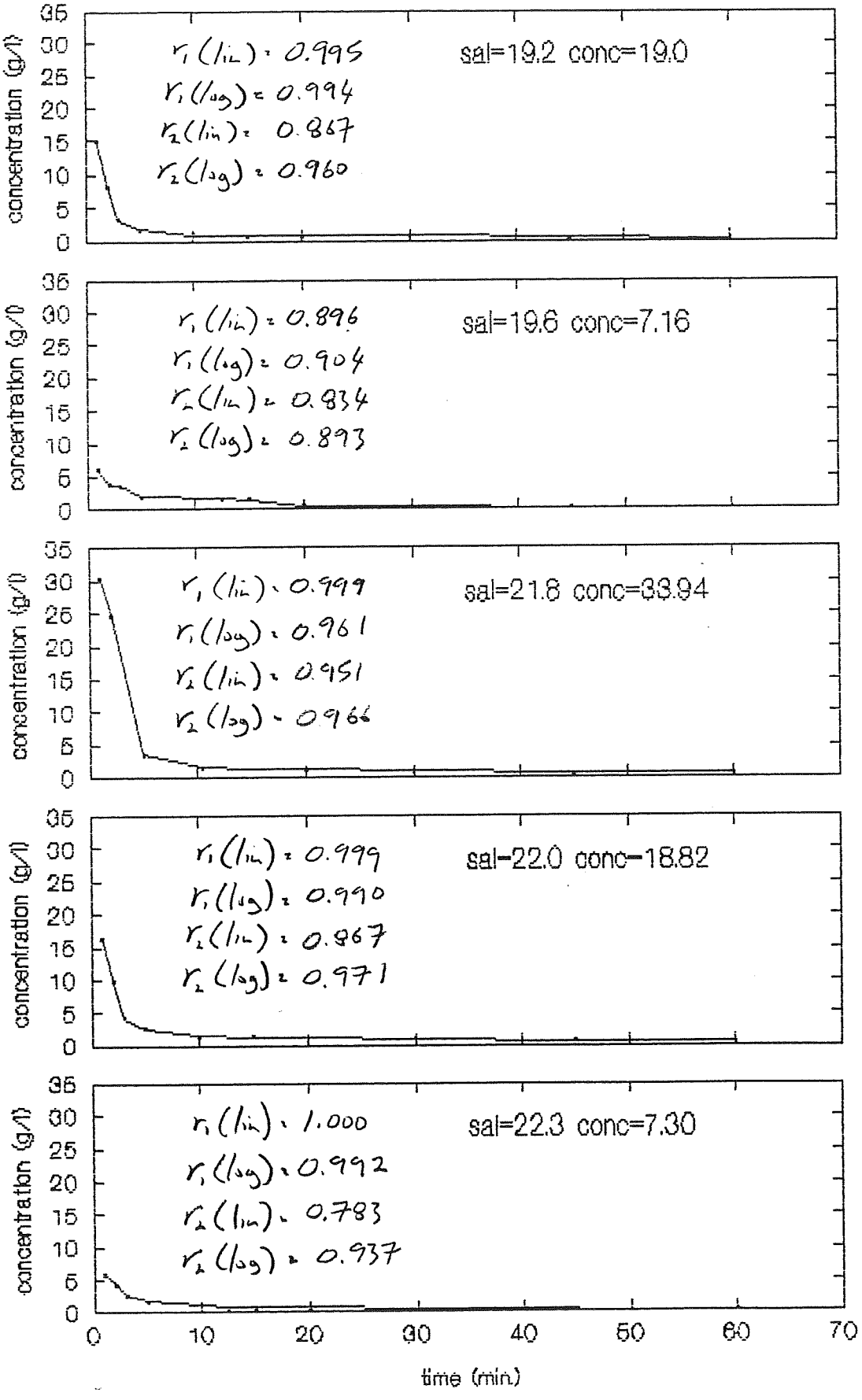
Station 18


concentration (g/l)
time (min)
r1 (lin) = 0.991
r1 (log) = 0.993
r2 (lin) = 0.841
r2 (log) = 0.905
sal=15.0 conc=13.67
r1 (lin) = 0.974
r1 (log) = 0.993
r2 (lin) = 0.766
r2 (log) = 0.855
sal=17.1 conc=7.05
r1 (lin) = 0.960
r1 (log) = 0.990
r2 (lin) = 0.903
r2 (log) = 0.986
sal=17.1 conc=10.3
r1 (lin) = 0.986
r1 (log) = 1.00
r2 (lin) = 0.960
r2 (log) = 0.991
sal=17.1 conc=12.61
r1 (lin) = 0.982
r1 (log) = 0.986
r2 (lin) = 0.735
r2 (log) = 0.920
sal=17.2 conc=2.74

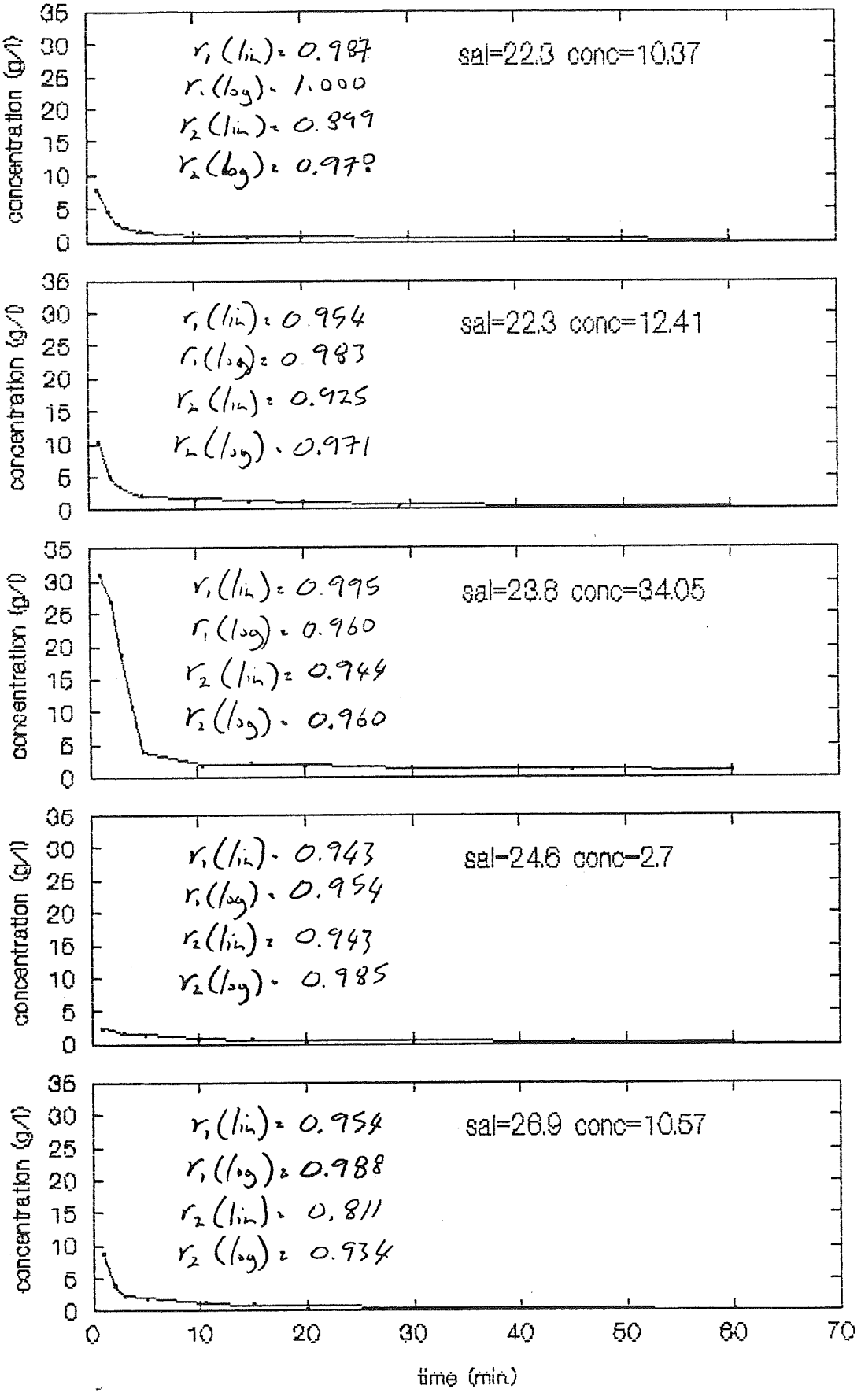
Station 18


sal=17.6 conc=18.74
sal=17.8 conc=33.31
sal=18.0 conc=3.06
sal=19.1 conc=10.64
sal=19.2 conc=12.58
concentration (g/l)
time (min)

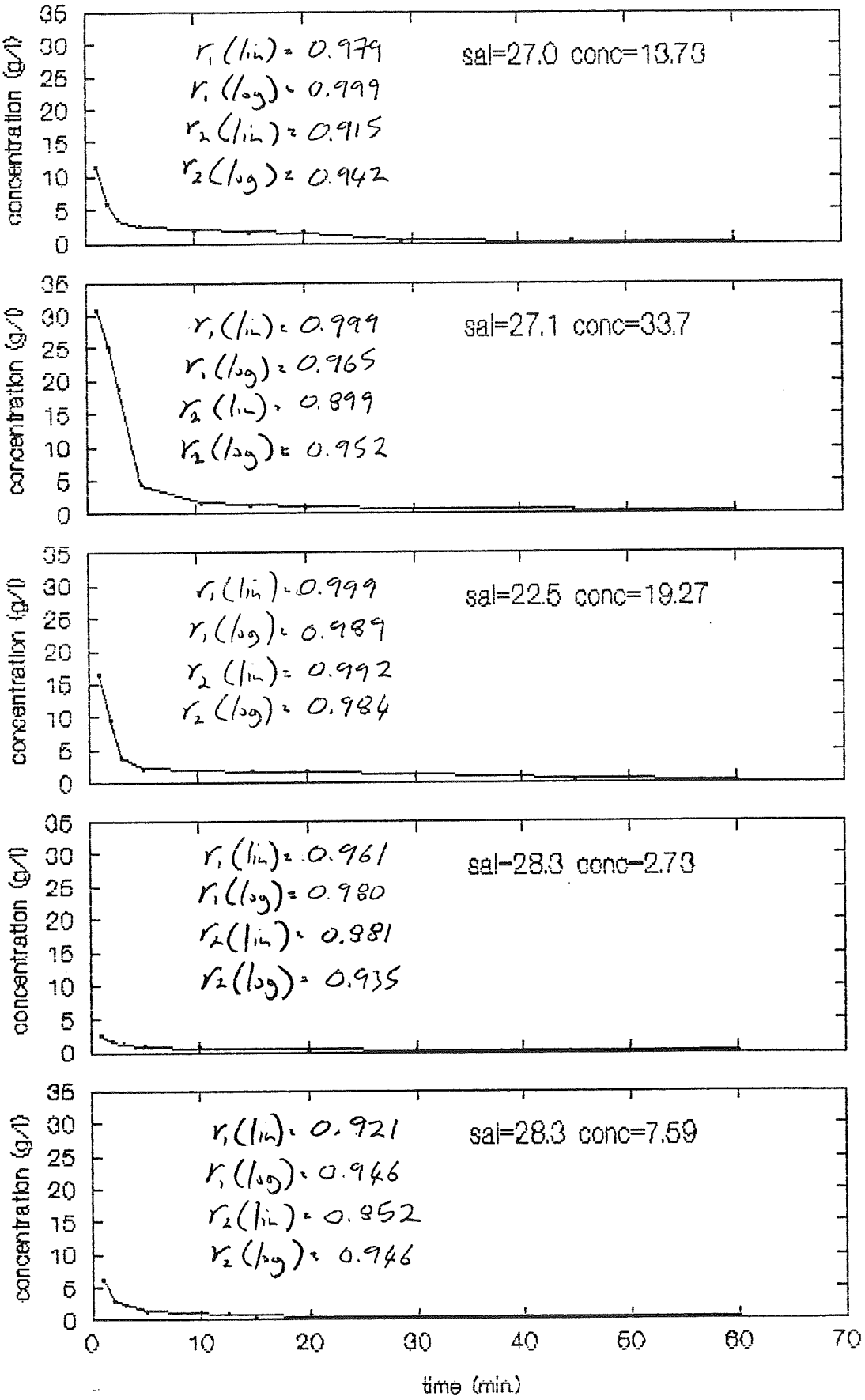
Station 18


concentration (g/l)
time (min.)
r1(lin) = 0.995
r1(log) = 0.994
r2(lin) = 0.867
r2(log) = 0.960
sal=19.2 conc=19.0
r1(lin) = 0.896
r1(log) = 0.904
r2(lin) = 0.834
r2(log) = 0.893
sal=19.6 conc=7.16
r1(lin) = 0.999
r1(log) = 0.961
r2(lin) = 0.951
r2(log) = 0.966
sal=21.8 conc=33.94
r1(lin) = 0.999
r1(log) = 0.990
r2(lin) = 0.867
r2(log) = 0.971
sal=22.0 conc=18.82
r1(lin) = 1.000
r1(log) = 0.992
r2(lin) = 0.783
r2(log) = 0.937
sal=22.3 conc=7.30

Station 18


concentration (g/l)
time (min)
r1(lin) = 0.987
r1(log) = 1.000
r2(lin) = 0.899
r2(log) = 0.978
sal=22.3 conc=10.37
r1(lin) = 0.954
r1(log) = 0.983
r2(lin) = 0.925
r2(log) = 0.971
sal=22.3 conc=12.41
r1(lin) = 0.995
r1(log) = 0.960
r2(lin) = 0.944
r2(log) = 0.960
sal=23.8 conc=34.05
r1(lin) = 0.943
r1(log) = 0.954
r2(lin) = 0.943
r2(log) = 0.985
sal=24.6 conc=2.7
r1(lin) = 0.954
r1(log) = 0.988
r2(lin) = 0.811
r2(log) = 0.934
sal=26.9 conc=10.57

Station 18


concentration (g/l)
time (min)
r_1 (lin) = 0.979
r_1 (log) = 0.999
r_2 (lin) = 0.915
r_2 (log) = 0.942
sal=27.0 conc=13.73
r_1 (lin) = 0.999
r_1 (log) = 0.965
r_2 (lin) = 0.899
r_2 (log) = 0.952
sal=27.1 conc=33.7
r_1 (lin) = 0.999
r_1 (log) = 0.989
r_2 (lin) = 0.992
r_2 (log) = 0.984
sal=22.5 conc=19.27
r_1 (lin) = 0.961
r_1 (log) = 0.980
r_2 (lin) = 0.981
r_2 (log) = 0.935
sal=28.3 conc=2.73
r_1 (lin) = 0.921
r_1 (log) = 0.946
r_2 (lin) = 0.852
r_2 (log) = 0.946
sal=28.3 conc=7.59