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SRP BASELINE HYDROGEOLOGIC INVESTIGATION: AQUIFER CHARACTERIZATION

Groundwater Geochemistry of the Savannah River Site and Vicinity (U)

Richard N. Strom

Dawn S. Kaback

Environmental Sciences Section
Savannah River Laboratory
Westinghouse Savannah River Company
Aiken, SC 29808

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT
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Richard N. Strom
Dawn S. Kaback

March 31, 1992

Authentication Richard N Strom

Approved by: DBmoore-Shedrow
D.B. Moore-Shedrow, Manager
Environmental Sciences Section
Savannah River Laboratory

Environmental Sciences Section
Savannah River Laboratory
Westinghouse Savannah River Company
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Westinghouse
Savannah River Company

P.O. Box 616
Aiken, SC 29802

cc: R. N. Strom, 773-42A
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Approved by: DBMoore-Shedrow
D.B. Moore-Shedrow, Manager
Environmental Sciences Section
Savannah River Laboratory

Environmental Sciences Section
Savannah River Laboratory
Westinghous Savannah River Company
Aiken, SC 29808

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ABSTRACT

An investigation of the mineralogy and chemistry of the principal hydrogeologic units and the geochemistry of the water in the principal aquifers at SRS was undertaken as part of the Baseline Hydrogeologic Investigation. This investigation was conducted to provide background data for future site studies and reports and to provide a site-wide interpretation of the geology and geochemistry of the Coastal Plain Hydrostratigraphic province. Ground water samples were analyzed for major cations and anions, minor and trace elements, gross alpha and beta, tritium, stable isotopes of hydrogen, oxygen, and carbon, and carbon-14. Sediments from the well borings were analyzed for mineralogy and major and minor elements.

The aquifers are composed largely of only slightly reactive minerals-principally quartz and various feldspar and clay minerals. Carbonate units are restricted to the Tertiary-aged units and are important to the geochemistry of the water only in those aquifer units southeast of Upper Three Runs Creek.

The majority of the waters are low in total dissolved solids and slightly acidic. In the Cretaceous aquifers, the chemistry is controlled primarily by the dissolution of silicate minerals and by the microbial oxidation of lignite within the aquifers. In most portions of Aquifer Units IA and IB, the waters are low in dissolved oxygen (< 0.1 mg/l) and high in dissolved iron, up to 5 mg/l. In the Tertiary aquifers south of Upper Three Runs Creek, calcium and bicarbonate are the predominant ions, due largely to chemical reactions between ground water and the calcite-rich units that are scattered sporadically through the Tertiary section.

Background tritium values for recent precipitation (post-1950) are common in ground waters to depths of >150 feet below land surface. Interpretation of the carbon-14 analyses of selected water samples was undertaken by Pacific Northwest Laboratories. The results, based on computer modeling of the chemical reactions along the flow paths, indicate that the oldest waters beneath the Savannah River Site are found in Aquifer Unit IA and have ages slightly greater than 8,000 yBP.

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INTRODUCTION

The Baseline Hydrogeologic Investigation was initiated in the mid-1980's to update and improve the information and understanding of the hydrogeologic systems underlying the Savannah River Site (SRS) and the surrounding area. The investigation included the installation of clusters of observation wells screened in varying aquifers and the coring of sediments of the Cretaceous and Tertiary-aged units in unimpacted areas of the site. Details of the coring operation and the installation of the monitor wells for the investigation are documented in Bledsoe *et al.* (1990) and in the documents cited therein.

Data on the mineralogy of the sediments and on the geochemistry of the ground water from the observation wells on the site and the surrounding areas of South Carolina were collected to delineate the hydrochemical facies that define areas of similar groundwater chemistry, to evaluate and describe the geochemical evolution taking place in the groundwater flow systems, and to calculate the age of the ground water in the various aquifer units beneath the site. These data can be used to establish the nature and distribution of chemical species in the ground water, to determine reaction mechanisms between water and the enclosing materials, and to aid in the interpretation of flow paths and residence times of the aquifer waters.

The chemistry of the ground water is profoundly affected by both the source of the water (e.g. precipitation, recharge from streams, lakes or ponds, treatment plant effluents, etc.) and by reactions between the soils, sediments, or rock material with which the water has been in contact during the course of migration. Biological activity within the sediments alters the chemical balances within the water and the speciation of dissolved constituents. As ground water travels from recharge areas toward zones of discharge, the chemistry of the water evolves as a result of both chemical and biochemical reactions.

A thorough understanding of the geochemical evolution that has taken place within the ground waters can be used to predict and determine conduits for transport between water-bearing units, the limitations of the groundwater resources, the extent of biological activity within the subsurface and can provide a better overall understanding of the hydrogeology of the Savannah River Site.

Geologic Setting of the Savannah River Site.

The Savannah River Site lies on the Atlantic Coastal Plain about 20 miles southeast of the edge of the Piedmont Physiographic Province. The Coastal Plain is underlain by a seaward dipping wedge of sediments that thins and overlaps the crystalline rocks of the Piedmont (Figure 1). Early investigations of the hydrogeology at the site, such as Siple (1967), established three geologic and hydrogeologic systems on the site: 1) crystalline basement rocks composed of metamorphic and intrusive igneous rocks; 2) well-indurated Triassic-aged sediments in the Dunbarton Basin; and 3) the overlapping, weakly consolidated Cretaceous to Recent coastal plain sediments.

The crystalline basement rocks have very low permeabilities. Water is stored primarily in the fractures and joints in the rocks. The permeability of the Triassic rocks is also likely to be relative low. Two test wells drilled into the Triassic rocks showed that the water in these rocks are geopressured and that the hydraulic heads of the waters are above land surface. The origin of the overpressuring is uncertain but has been ascribed to osmotic pressure across the overlying impermeable confining units (Marine, 1974).

Both the crystalline basement rocks and the Triassic rocks are overlain by varying thicknesses of weathering residue containing degraded minerals and clays. Overlying these old soils is a depositional blanket of indurated, poorly-sorted clayey sediments of the Cape Fear Formation (Bledsoe, 1988). This unit and the residual soils hydraulically separate and isolate the younger sedimentary materials from the Triassic sediments and the crystalline basement rocks.

The third hydrogeologic system is the Cretaceous and younger sedimentary units of the coastal plain sediments. The sediments were largely deposited in shallow marine and fluvial environments (Gohn, 1988). The thickness of the sedimentary units increases towards the southeast across the site. At the

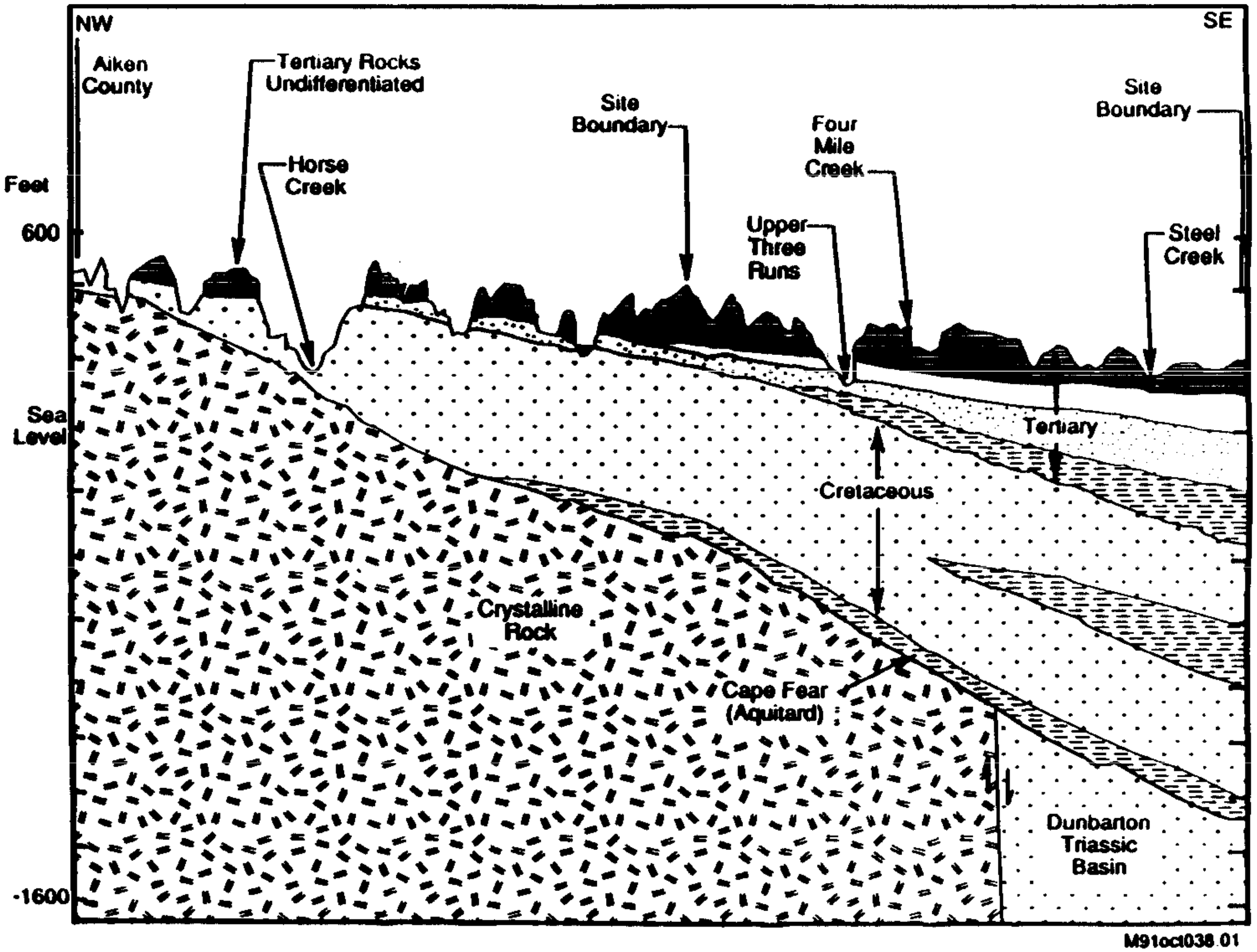


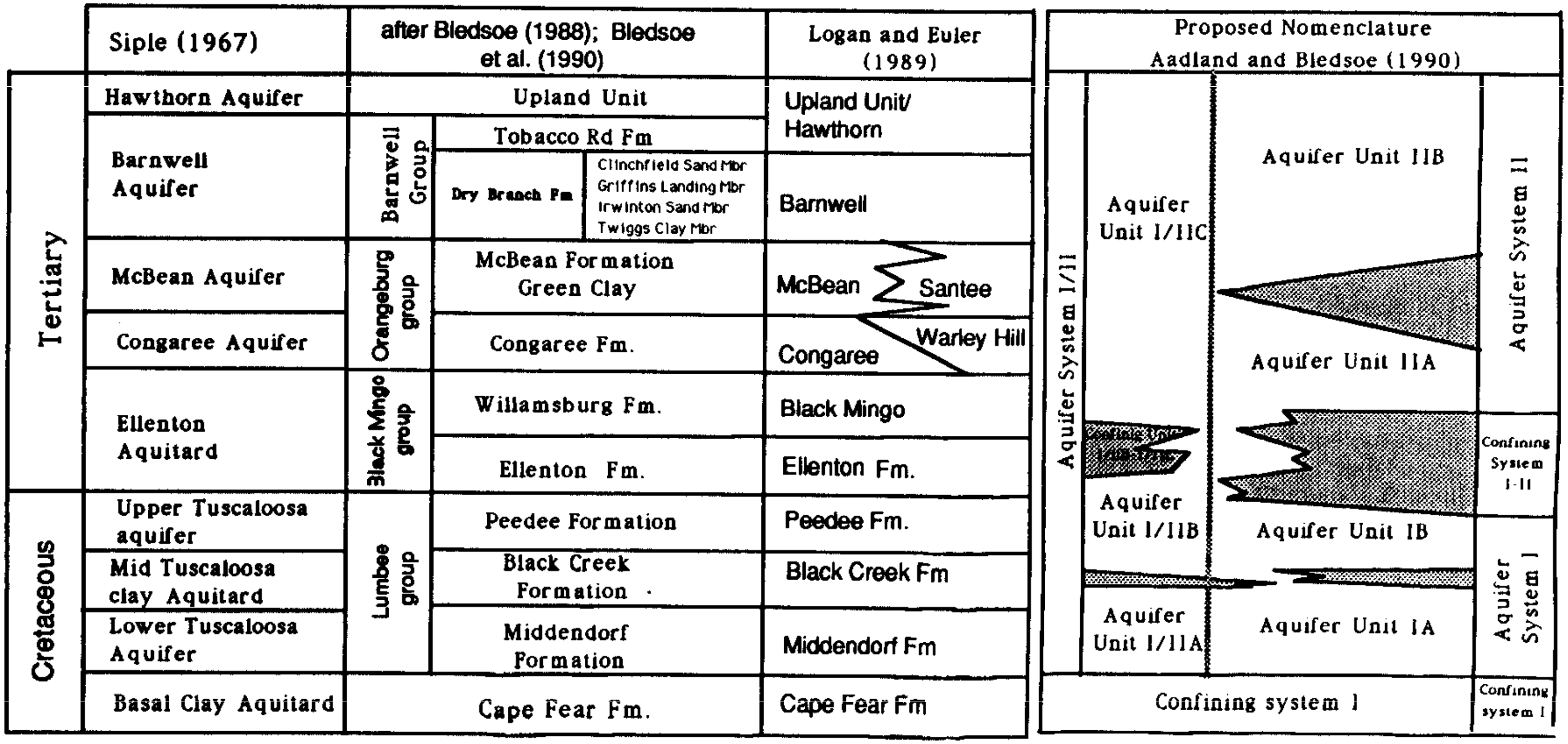
Figure 1. Geologic cross section through the Savannah River Site.

northwest boundary, the sedimentary section is about 700 feet thick, and it is about 1400 feet thick at the southeastern boundary (Fallaw, 1990). As more detailed information has become available the stratigraphic names applied to the various units have been modified based on the predilections of successive investigators. Several stratigraphic nomenclatural schemes have been proposed or are currently in use on the site or surrounding area. In this report, the stratigraphic nomenclature used by Bledsoe *et al.* (1990) has been employed to maintain the continuity and traceability of the data to the original documentation.

The principal aquifers on the site have frequently been named after the principal formations, for example the Barnwell Formation and the Barnwell Aquifer. As stratigraphic names have changed, the names of the aquifers have also changed as a result. Figure 2 compares the hydrostratigraphic nomenclature used in the mid-1960's with current stratigraphic and hydrostratigraphic nomenclature. The currently used nomenclature (Aadland and Bledsoe, 1990) takes into account the progressive thickening of the aquifers across the site and the effectiveness of the confining units that separate the aquifer units. The proposed changes avoid tying the aquifer nomenclature to the stratigraphic names. The use of numeric labels, eg. Aquifer IA is a temporary expedient and will be replaced by formal hydrostratigraphic names as a consensus is developed in the hydrogeologic committee. A map view, Figure 3, shows the approximate limits of the coastal plain aquifer systems.

The residual soils of the basement rocks and the dense clays of the Cape Fear Formation make up the bottom confining unit or aquitard of the coastal plain hydrogeologic system. Overlying this confining unit are two aquifers in Cretaceous sands (Aquifer IA and IB). These sands are generally considered to be prolific water producers and are generally the source for water-supply wells on the site. They are separated from each other by the relatively less permeable beds that make up the Black Creek Formation.

The Tertiary aquifers are separated from the underlying Cretaceous aquifer units by confining beds of the Black Mingo Group, especially the Ellenton Formation. On the northwestern corner of site, the separation is not as



	Siple (1967)	after Bledsoe (1988); Bledsoe et al. (1990)		Logan and Euler (1989)
Tertiary	Hawthorn Aquifer	Upland Unit		Upland Unit/ Hawthorn
	Barnwell Aquifer	Barnwell Group	Tobacco Rd Fm	
			Dry Branch Fm: Clinchfield Sand Mbr Griffins Landing Mbr Irwinton Sand Mbr Twiggs Clay Mbr	Barnwell
	McBean Aquifer	Orangeburg group	McBean Formation Green Clay	McBean Santee
	Congaree Aquifer		Congaree Fm.	Congaree Warley Hill
	Ellenton Aquitard	Black Mingo group	Willamsburg Fm.	Black Mingo
			Ellenton Fm.	Ellenton Fm.
Cretaceous	Upper Tuscaloosa aquifer	Lumbee group	Peedee Formation	Peedee Fm.
	Mid Tuscaloosa clay Aquitard		Black Creek Formation	Black Creek Fm
	Lower Tuscaloosa Aquifer		Middendorf Formation	Middendorf Fm
	Basal Clay Aquitard	Cape Fear Fm.		Cape Fear Fm

Figure 2. Comparison of Stratigraphic and hydrostratigraphic nomenclature

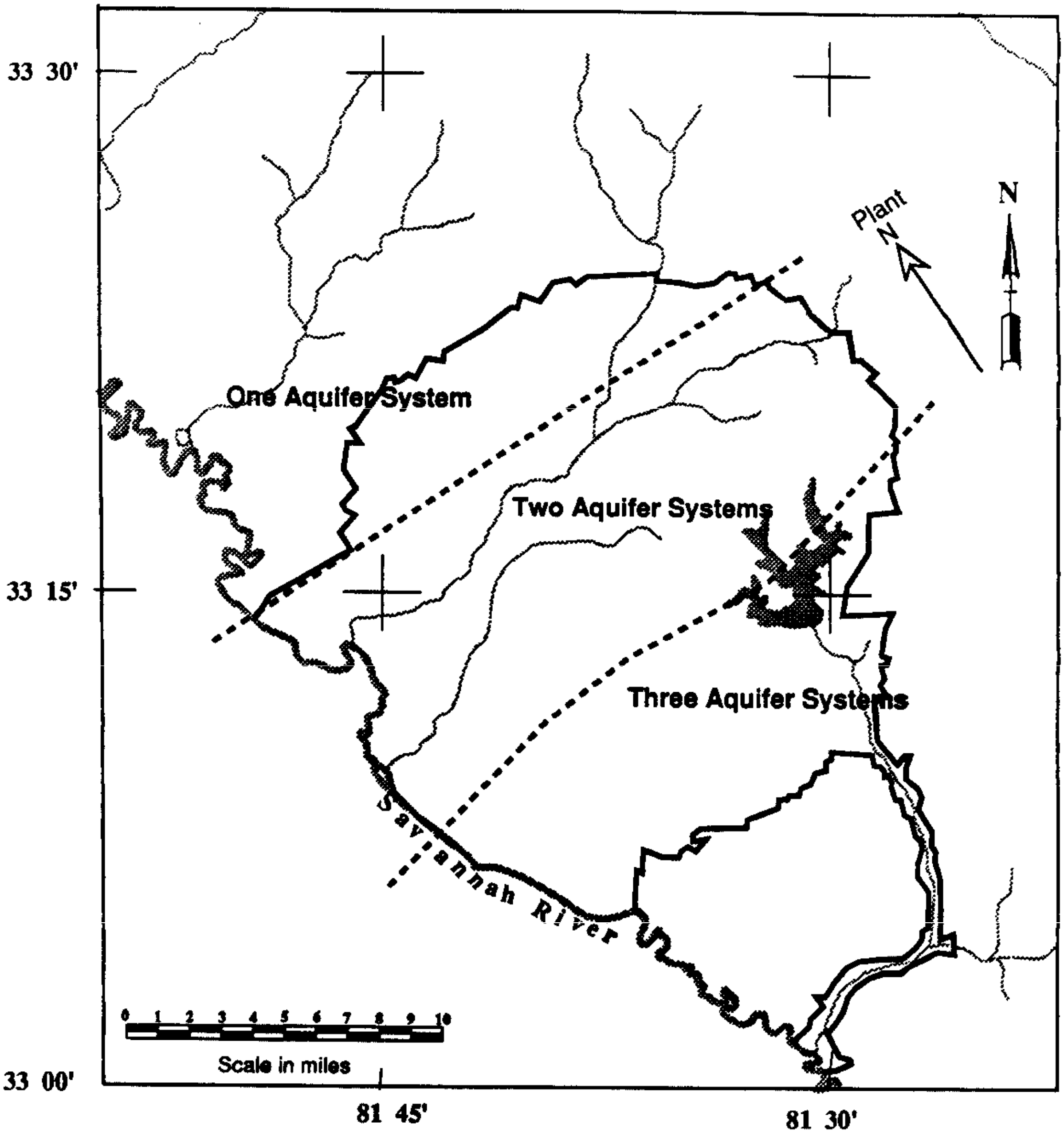


Figure 3. Geographic limits of effective confining units.

effective as in the central and southern portion of the site. Where there is a downward hydraulic gradient in the northwestern portion of the site, recharge to the Cretaceous aquifers occurs from the Tertiary units (eg. see Strom and Kaback, 1990).

In the central and Southern area, the Tertiary section can be divided into two separate aquifers, Aquifer Unit IIA (Formerly called the "Congaree Aquifer") and Aquifer Unit IIB (frequently referred to as the "Barnwell Aquifer" or "Watertable Aquifer"). The aquitard or confining beds that separate these two units is a glauconitic clayey zone of the McBean Formation that is locally referred to as the "green clay." This clay pinches out and becomes more sandy towards the northwest.

The position of the water table is controlled primarily by local topographic features. The surface of the Atlantic Coastal Plain at the site is a relatively flat plateau (the Aiken Plateau) that has been dissected by stream erosion. The incision of the streams has left relatively isolated, flat-lying surfaces separated by 90 to 125 feet deep stream valleys. The depth to the water table below land surface varies from 0 feet, when it outcrops in the stream valleys or wetlands, to a depth of 125 feet below the remnant plateau areas. The depth of the water table is usually controlled by the elevation of the nearest tributary stream of the Savannah River. At many localities on site the water table is situated in Tertiary sediments of low water-producing capabilities and perched water tables exist sporadically across the site.

The direction of groundwater flow at any locality may change or even reverse as one goes into successively deeper aquifers (Marine *et al.*, 1983). The aquifers in the Tertiary sediments receive local recharge and flow is generally toward nearby stream valleys. In general, flow at the water table is toward minor tributaries and deeper Tertiary aquifers flow toward major tributaries of the Savannah River. The deepest aquifers at SRS, Aquifer System I, receive recharge in the outcrop areas of the Cretaceous sediments to the north of the site. Groundwater flow beneath the site in system I is toward the Savannah River.

Over much of the site, the potentiometric surface, or hydraulic "head" of the deeper aquifers in the Cretaceous sediments is higher than that of the overlying Tertiary aquifers (Christensen and Gordon, 1983). This upward gradient is an important characteristic at many of the site's waste disposal areas and has provided protection from downward transport of contaminants to the deeper aquifers on the site. Figure 4 outlines the areas where there is an upward hydraulic gradient across the confining units near the Cretaceous-Tertiary boundary (Looney *et al.*, 1990).

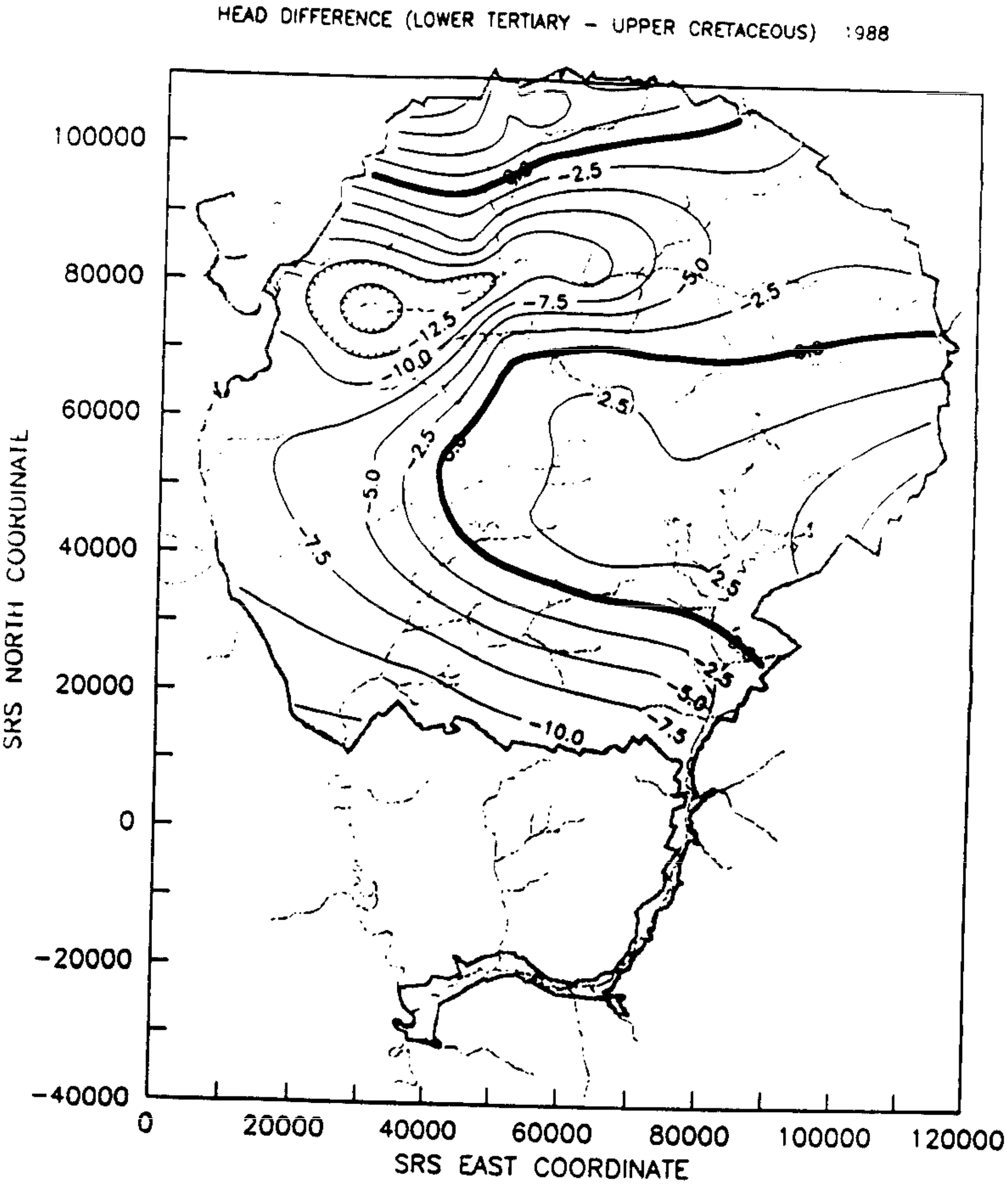


Figure 4. Potential (head) difference map between the upper Cretaceous aquifers and the lower Tertiary Aquifers. Positive values indicate downward hydraulic gradients (from Looney *et al.*, 1990).

METHODS

Sediment Sampling.

The drilling program conducted for the Baseline Hydrogeologic Investigation included the coring of more than 16,000 feet of sediments at 18 widely-spread, non-impacted well cluster localities within the boundaries of the site (localities P-13 to P-30, Figure 5). Samples of the sediment were taken from the cores for chemical and mineralogical examination. The sandier units, representative of the more transmissive units, were sampled as well as occasional samples from the aquitards and/or units of unusual appearance. In all, 220 samples were selected for analysis. Lithologic logs for the core holes from which the samples were selected are given in the SRP Hydrogeologic Investigation reports for phases I, II, and III (Bledsoe 1984, 1987, 1988).

The sediment samples were analyzed by the mineralogical laboratories at Conoco, Inc. by powder X-ray diffraction (XRD) and by X-Ray fluorescence (XRF). The clay mineralogy on the "less than" 2u fraction of a separate subsample was determined by X-ray Diffraction. The analytical results are presented in appendix II, tables 1 and 2.

Groundwater Sampling

A single round of groundwater samples was collected for this aquifer characterization study during the period of November, 1988 to April, 1989. Samples were collected from cluster wells installed during the Baseline Hydrogeologic Study, from cluster wells installed under the South Carolina Water Resources Commission's regional drilling program (Logan, 1987; Kuntz, *et al.*, 1988, 1989), and from selected production wells surrounding the Savannah River Site. Figure 5 shows the locality of the wells sampled and Appendix I gives the coordinates and construction data for these wells. Each of the Savannah River Site monitor wells had a permanent, submersible centrifugal pump installed at the time of construction. Details of the construction and pump installation are described in Bledsoe (1984, 1987, 1988). Several of the monitoring wells could not be accurately sampled during this

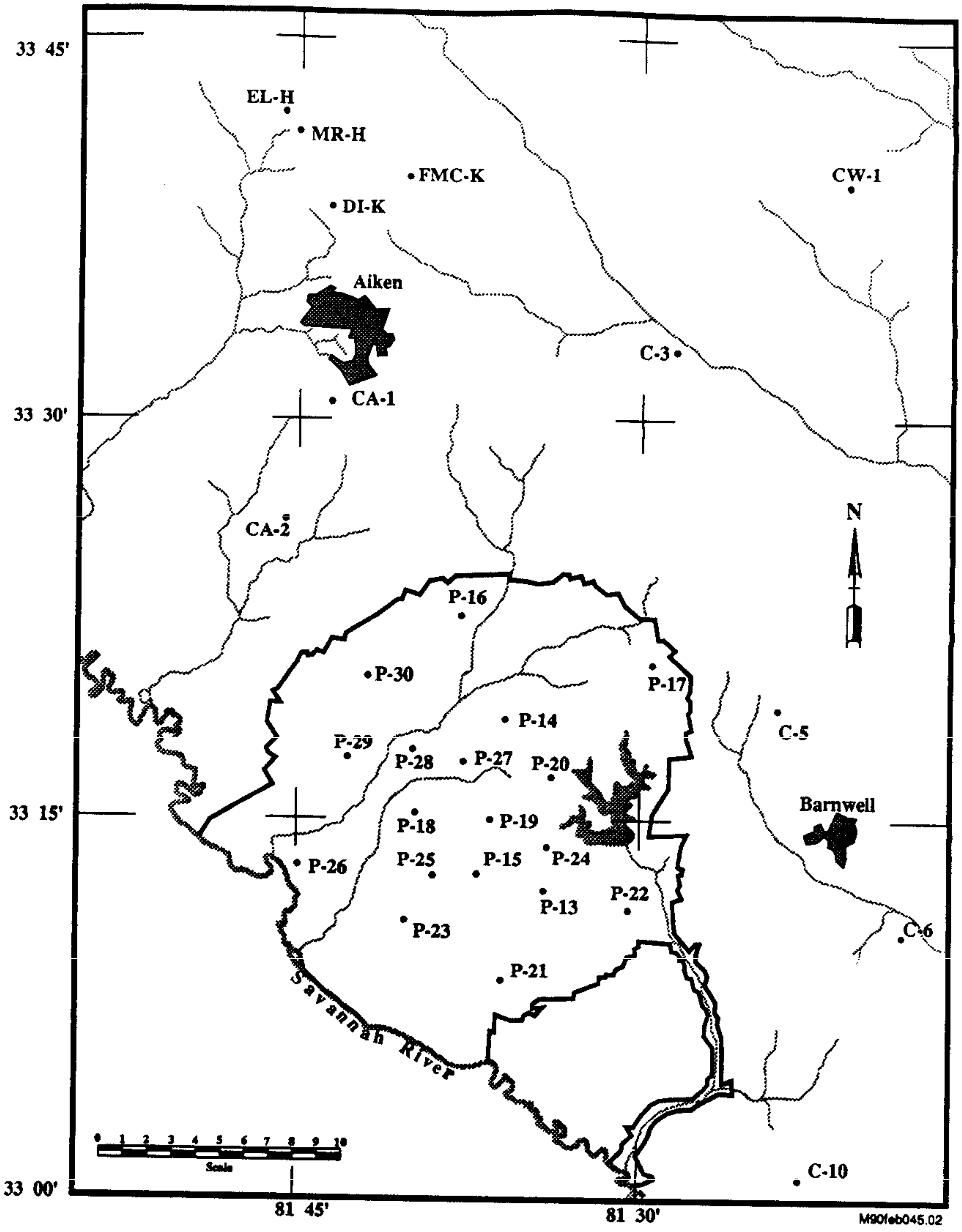


Figure 5. Well location map.

investigation due to contamination by cement grout, indicated by elevated pH measurements, insufficient water yield of the formation, or dry wells. In all, some 105 wells in the coastal plain sedimentary sequence were sampled and analyzed.

Details of the sampling procedures are described in Westinghouse 3Q5 Procedure Manual, the standard operating procedures for monitoring-well sampling on the Savannah River Site. Wells were pumped for a minimum of 4 well volumes and until the pH, conductivity, and temperature measurements had stabilized. Alkalinity titrations were performed in the field using a Hach digital titrator to the methyl orange end point. The field parameters; pH, conductivity, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP), were measured using a "Hydrolab Datasonde 1" with the sensors of the instrument enclosed in a flow-through cell connected to the sample discharge line.

The sensors on the instruments were calibrated daily following the manufacturers recommended procedures (Hydrolab, 1986). The pH electrodes were calibrated using NIST (NBS) pH 4 and pH 7 buffers and the conductivity bridge with 0.0010 KCl solution (147 umhos). The response of the oxidation-reduction potential (ORP) electrode pair was checked against quinhydrone solutions prepared using pH 4 and pH 7 buffer solutions. In the the data table (Appendix III, table 1), both ORP (the emf of the solution vs the Ag/AgCl half-cell measured in the field) and the estimated Eh are reported. Eh was estimated by calculating the theoretical difference between the emf of the Ag/AgCl and that of the hydrogen half cell at the ambient temperature of the groundwater and adding that value to the ORP recorded in the field. Samples were collected and preserved for analysis using containers and preservation methods indicated in table 1 and were stored on ice or refrigerated.

Several different laboratories were used for the analysis of these samples. The analytical laboratories are identified in the data tables in the appendices using the following abbreviations:

Table 1. Groundwater sample containers and preservatives.

No.	Analytes	Container	Filtration	Preservation
1	radionulides	1 l plastic	yes	$HNO_2$to pH<2
2	metals	250 ml plastic	yes	HNO_3 to pH<2
3	isotopes	4 l glass	no	none
4	tritium	180 ml gas sample bottles	no	none
5	TDS	500 ml glass	yes	none
6	TKN	500 ml glass	no	H_2SO_4 to pH<2
7	NH_3-N	250 ml glass	no	H_2SO_4 to pH<2
8	HCO_3-CO_2	250 ml glass	no	none
9	TOC	250 ml AG/S (1)	no	HCl to pH <2
10	NO_3-N	250 ml plastic	no	H_2SO_4 to pH<2
11	NO2-N	250 ml plactic	no	1 ml sat. $HgCl_2$
12	iodine	250 ml plastic	no	H_2SO_4 to pH<2
13	Br, Cl, F, SO_4	250 ml plastic	no	none

(1) AG/S = amber glass with septum

Conoco - Conoco Environmental Services, Ponca City, OK.
UGA - Laboratory of Dr. David B. Wenner, Department of Geology, University of Georgia, Athens, GA.
UW - Environmental Isotope Laboratory, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario.
UA - NSF-Arizona AMS Facility, University of Arizona, Tucson, TX.
GE-HY - GE-HY Environmental Sampling, New Ellenton, SC.

The analytical results reported for the groundwater sampling are presented in the appendix III. For the purpose of legibility, they are divided into several tables:

Table 1: Field data and major ions.
Table 2: Isotope and radiological data.
Table 3: Minor and trace elements.

Data Evaluation

The results of the analyses of groundwater samples were evaluated to determine reproducibility, accuracy, and internal consistency. By-in-large, the water samples collected were of very low ionic strength ground water and suffer somewhat from the imprecision of the analytical techniques used for the determination of the major ions. Major ion analyses were evaluated using charge balances and the sum of dissolved solids verses the analyzed total dissolved solids (TDS). The charge balance equation used was:

$$\%ERROR = \frac{C^{+} - C^{-}}{(C^{+} + C^{-})} \times 100$$

where C^{+} = meq. cations
C^{-} = meq. anions

the H+ concentration was estimated from pH and HCO_3^- from the equation;

$$HCO_3^- = \text{Alkalinity (as } CaCO_3) / 0.82$$

Two alkalinity data sets were available for these calculations. Field alkalinity determined at the time of sampling, and laboratory alkalinities determined by the contracted analytical laboratory. In general there was good agreement between the two data sets (Figure 6) though the laboratory alkalinities tended to be somewhat higher than the field alkalinity data. The two sets were compared to determine which set of alkalinity data provided the least error in the ion balance test.

Testing the ion balance of the solutions (see Figure 7) showed that the mean ion balance for the data set was near neutrality, however at very low ionic strengths, <.001, cation or anion imbalance could be as great as 50%. The majority of the error appears to be related to the determination of alkalinity. Quite different ion balances are obtained if the calculations are performed using the alkalinity determined in the field, versus using those determined in the laboratory. The ion balances calculated using laboratory alkalinities were generally negative (mean = -9.3%). The ion balance calculated using field alkalinities were generally closer to neutrality (mean = -1.4%). In either case however, the dispersion of the data from neutrality at low ionic strengths was severe. For the purposes of this report, the field alkalinity is used in the geochemical calculations and illustrations.

Total dissolved solids (TDS) measurements are generally used to grossly approximate the total concentration of dissolved inorganic species. The values determined for TDS may not agree with the calculated values (APHA, 1985). However, the comparison can be useful in finding transcription errors, major analytical errors, or systematic procedural errors. Estimated values for TDS were calculated from the analytical data by the equation

$TDS = \sum cations + \sum anions + SiO_2$.

HCO_3^- = is converted to $CO_3^{=}$ in the sum of anions by the conversion:

$CO_3^{=} = 0.49\ HCO_3^-$.

The comparison of the analyzed versus the estimated TDS, Figure 8, did not show any systematic analytical or procedural errors, however the large dispersion of the data about the theoretical 1:1 slope indicates again the problem of precision of analytical techniques in the dilute waters in this portion of the coastal plain.

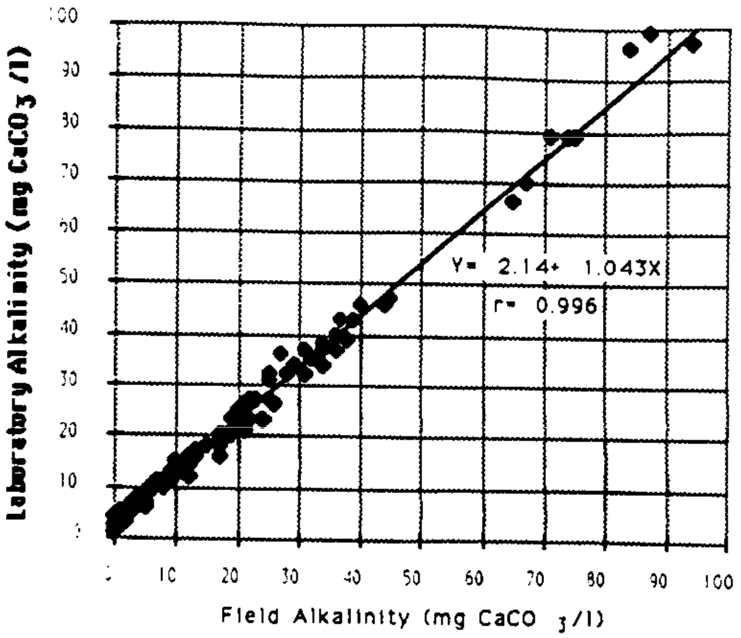


Figure 6. Comparison of Field and laboratory analytical data

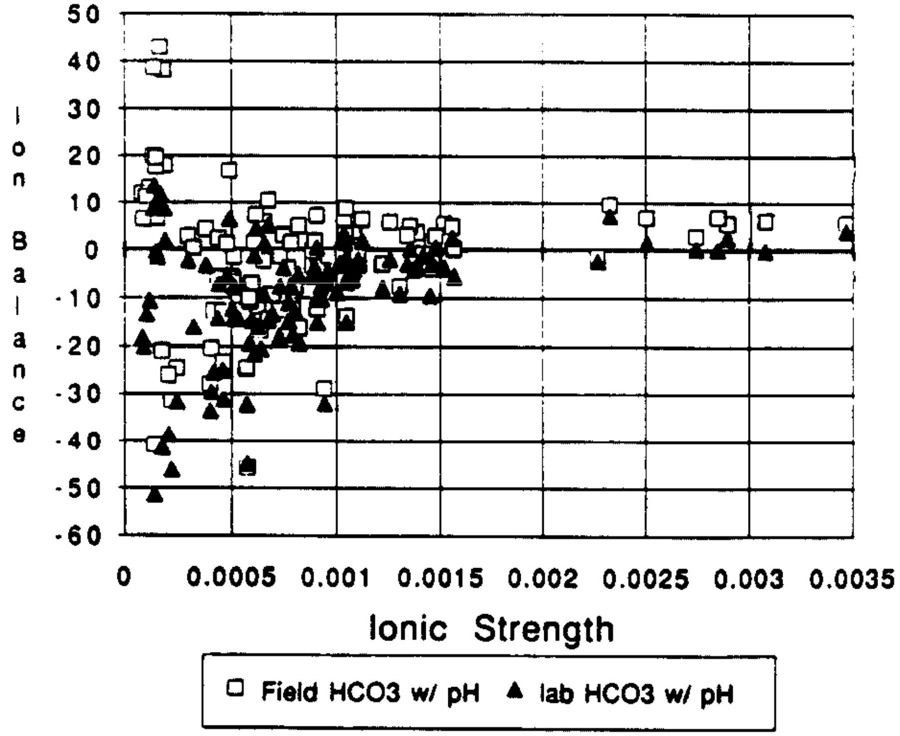


Figure 7. Ion balance from analytical data. Field and lavborabory alkaliniities were used separately to calculate ion balances. Hydrogen ion concentrations were calculated from field pH.

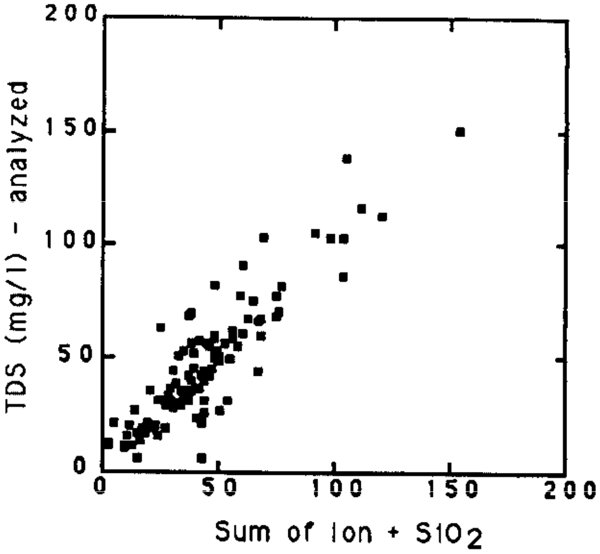


Figure 8. Comparison of measured and calculated total dissolved solids.

DISCUSSION

The quality of ground water in the principal hydrologic systems beneath the Savannah River Site depends on both the source of the water and the inorganic and biochemical reactions that take place along the flow path of the water. It is strongly influenced by the chemical composition and mineralogy of the enclosing geologic materials. Previous investigations have described the mineralogy and geochemistry of the crystalline basement rocks (Marine, 1967; Siple, 1967) and Triassic rocks in the Dunbarton Basin (Brown *et al.*, 1979; Marine, 1974, 1976; Marine and Siple, 1974) underlying the Savannah River Site. The mineralogy of the coastal plain sediments have also been described in numerous investigations of stratigraphy and hydrology in the region (eg. Gelting, 1990). In the current investigation an effort was made to augment the available data and in particular, to document the mineralogy of the aquifer units at each of the P-well cluster sites.

Sediment Mineralogy and Geochemistry

The results of X-ray diffraction and X-ray fluorescence analyses are presented in Appendix II. In general, quartz is the dominant mineral in the siliciclastic aquifers. Since quartz is largely nonreactive, its influence on water quality is negligible. The reactive silicate components of the coastal plain sediments include feldspars and a variety of phyllosilicates including mica and clay minerals. A zeolite mineral, clinoptilolite, was encountered during this investigation in core samples from the McBean and Congaree Formation from the P-21 well cluster on the southern edge of the site.

Though they have a marked effect on groundwater chemistry, nonsilicate minerals are generally uncommon in the aquifers underlying SRS. Those identified by X-ray diffraction in core samples include pyrite and marcasite, gypsum, barite, calcite, and hematite. Pyrite in trace or minor amounts was the most frequently identified nonsilicate mineral. Calcite was a major component (37%) in only one sample- a McBean Formation sample from the P-23 well cluster in the southwest portion of the site.

The X-ray fluorescence data (Appendix II, Table 2) underscore the degree to which the typically low-solubility siliceous minerals and residual oxides dominate in these aquifers. Silica ($SiO2$), Al_2O_3, Fe_2O_3, and TiO_2 typically account for more than 98% of the (normalized) chemical constituents of the sediments.

In spite of the high degree of chemical maturity or leaching indicated by the chemical compositions and the mineralogy, a diverse suite of clay minerals is found in the less than 2u fraction of the sediment samples. Kaolinite is the predominant clay mineral but by no means the exclusive phyllosilicate found (Figure 9) Smectite (montmorillonite or other expansible-layer clay) is found in all of the geologic units and predominates in the Dry Branch, McBean, and Congaree Formations. Illite is ubiquitous in minor to trace amounts. A mixed-layer clay (illite/vermiculite?) has been tentatively identified in some Dry Branch Formation materials. A significant amount of valuable information remains to be collected concerning the distribution of clay minerals at the Savannah River Site and on their effects on water chemistry and groundwater quality at the site.

Groundwater Geochemistry

General Observations

Within the Coastal Plain sediments the waters are generally of low total dissolved solids and slightly acidic. The pH values range from as low as 4.9 to a maximum value of 7.7 where ground water is in contact with limestone. The average pH value is about 6.0. The result of the baseline sampling program also shows that there is a well established geothermal gradient within the Coastal Plain section. When temperatures of the ground water are plotted against depth of the screened intervals, Figure 10, an average geothermal gradient of about 1.3 ^{o}C per 100 meters (0.4 ^{o}C/100 ft) can be seen in the data. Water temperatures are higher in the water table than would be estimated from the mean annual surface temperature of the air (about 17.8 ^{o}C).

Most of the shallow ground water is derived from local, recent precipitation as indicated by the concentrations of tritium in the water. At the Savannah

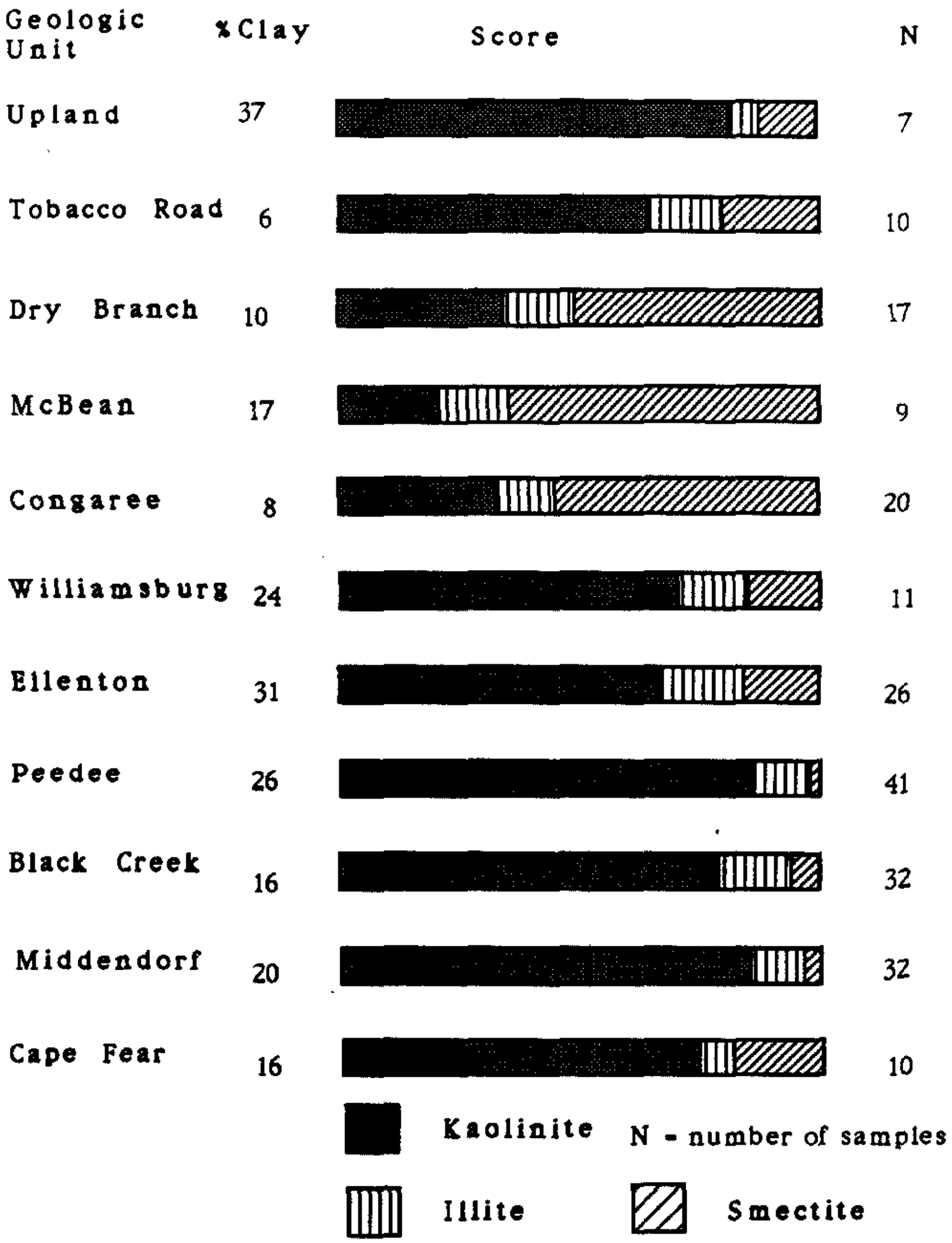


Figure 9. Clay mineralogy of selected samples. The percentage clay is based on selected samples and is not necessarily representative of the formations. The relative proportions of the clay minerals are based on nonquantitative data and therefore are only approximations.

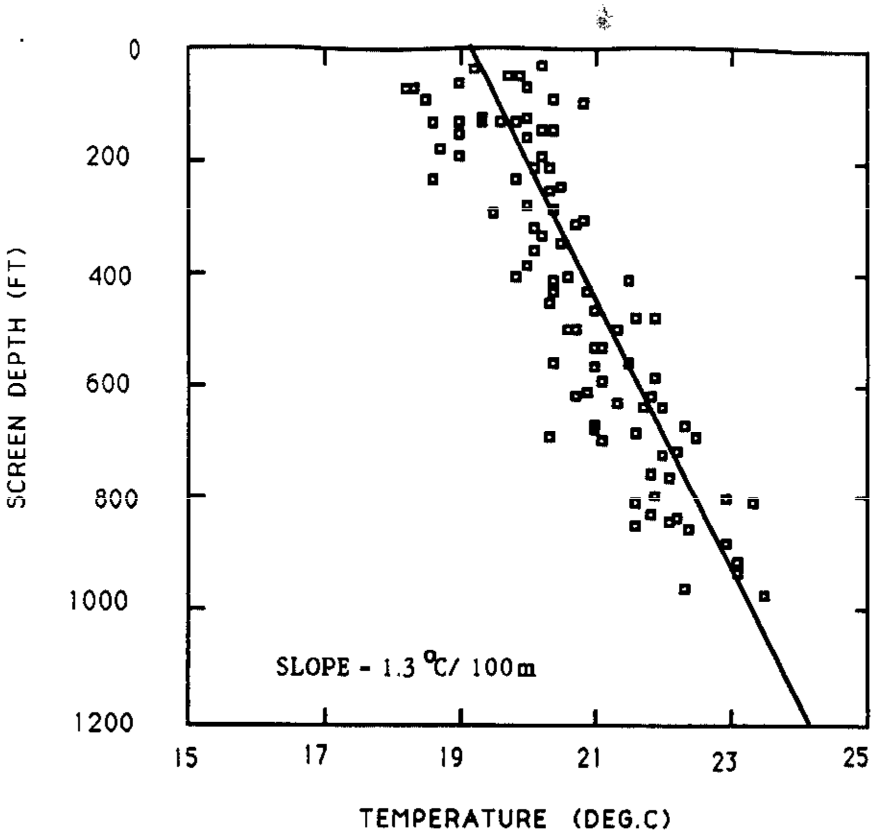


Figure 10. Geothermal gradient in SRS coastal plain section

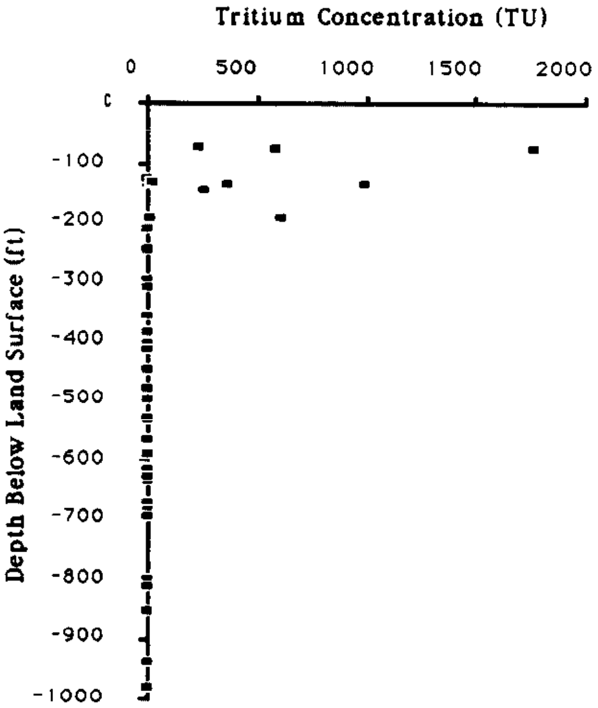


Figure 11. Tritium concentration as a function of depth. Tritium values greater than about 100 TU represent depositon since the beginning of plant operations in the early 1950's.

River Site, tritium in local precipitation has been in excess of the normal background levels in the northern hemisphere. The majority of tritium released from the site has been to the atmosphere- amounting to more than 24 x 10^6 Ci since the beginning of plant operation in 1954 (Murphy *et al.*, 1990). Washout from the atmosphere during periods of precipitation have elevated the concentration of rainfall tritium to where pre- and post-1954 rainfall derived water can be clearly distinguished in ground water (Strom and Kaback, 1992). Forty-five of the samples collected from P-wells were analyzed at the Environmental Isotope Laboratory at the University of Waterloo for tritium using low-level detection techniques. The results are presented in Appendix II, table 2. The samples from the less than 200 foot depth show values consistent with the expected values for post-1954 ground water derived from local precipitation. The deeper wells show tritium levels consistent with older waters (Figure 11). Gross alpha and beta are low in these background samples (Appendix III, table 2).

Analyses of the stable isotopes of hydrogen and oxygen in water were conducted. The stable isotope ratios do not indicate any anomalous sources for the ground water. Rainwater is depleted in ^{18}O and ^{2}H relative to sea water and condensation of atmospheric water vapor results in further fractionation as a result of the differences in vapor pressures of the isotopes in the water molecules. Precipitation becomes progressively more depleted (isotopically lighter) at higher latitudes, altitudes, or cooler mean annual temperatures. The stable isotope analyses performed at the University of Georgia are reported in Appendix II, table 2. These data cluster near the global meteoric water line (Craig, 1961) for recent precipitation as shown in Figure 12. The local meteoric line, based on data collected at the University of Georgia-Athens (Wenner *et al.*, 1991) is slightly higher than the global meteoric line and subparallel to it. The mean values for del ^{18}O = -4.5 $^{o}/oo$, del ^{2}H = -23.1$^{o}/oo$, are approximately those anticipated at this latitude under current climatic conditions. The mean values for waters that can be identified as modern on the basis of tritium concentrations, have slightly lighter compositions- del ^{18}O =-4.9, del ^{2}H = -24.2 $^{o}/_{oo}$ than the site average. None of these isotopic data suggest that the waters currently in the Coastal Plain Hydrogeologic System originated in either a much warmer or cooler climate than today's.

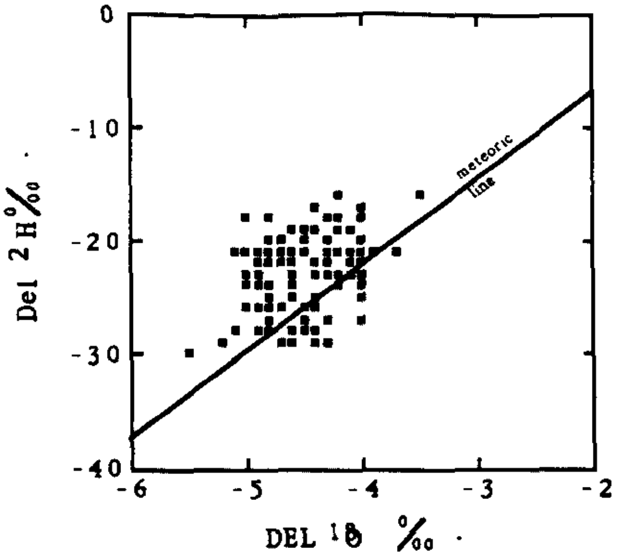


Figure 12. Stable isotope data for SRS ground waters

Hardegree (1990) used some of these data in an investigation of baseflow and streamflow in Upper Three Runs. Hardegree pointed out that the ^{18}O in the Cretaceous Peedee Formation waters is frequently slight enriched (isotopically heavier) compared to the waters in the underlying and overlying formations in a given well cluster. Comparison of the del ^{18}O and del ^{2}H in the Peedee groundwater samples compared to all other samples indicated that the Peedee values followed the same trends as other samples and did not cluster separately from the others. The observation by Hardegree warrants further investigation however and may suggest that some zones of stagnant water exist in the upper Cretaceous sections at some localities.

The ionic composition of the ground water also clearly reflects the meteoric origin of the water. The composition of rainwater is not monitored at the Savannah River Site, however, data from several nearby monitoring sites are available. Table 2 shows the analytical data from 3 sites. The water has approximately the same sodium to chloride ratio as sea water (Figure 13), a principal source of atmospheric salts, but higher values for sulfate and calcium. Both calcium and sulfate are commonly added to atmospheric salts during the passage of an air mass over land areas. The chloride generally behaves as a conservative constituent in water transport and it can frequently be used as a tracer of both the movement of water masses and the chemical evolution of the ground water. For example, when the Na concentration in the the P-well ground waters is plotted against Cl, Figure 15, two distinct trends appear.

> 1) The majority of the data plot on or near the sea water Na/Cl ratio. As the extent of evapotranspiration of meteoric water increases, the Na/Cl ratios remain the same but absolute values increase in the direction indicated in the figure. The average chloride concentration is about 5 times that of the mean precipitation value. The number is higher than would be predicted from the evapotranspiration rate of about 60% of precipitation for the SRS site calculate by Hubbard *et al.* (1988). Dry deposition of salts may be major contributor to ground water composition in the Savannah River Site region.

Table 2. Rainfall data for SRS Region. Belville, SNF (Sanatee National Forest), and Ulvalda. Data supplied by PNL.

location	year	H+ (ug/l)	Mg (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)	NH4+ (mg/l)	SO4 (mg/l)	HCO3 (mg/l)	Cl (mg/l)	NO3 (mg/l)
Belville	84	23.56	0.0413	0.1188	0.1986	0.0387	0.1755	1.4579	0.0111	0.0346	0.7464
Belville	85	19.12	0.0410	0.0953	0.2318	0.0270	0.0861	1.0663	0.0136	0.4324	0.5605
Belville	86	20.84	0.0285	0.0637	0.1743	0.0315	0.1090	1.2092	0.0125	0.3117	0.7432
Belville	87	28.89	0.0305	0.0578	0.1976	0.0431	0.1385	1.4502	0.0090	0.3543	0.8692
Belville	88	22.24	0.0283	0.1153	0.1762	0.0767	0.1135	1.4148	0.0117	0.2996	0.6891
SNF	85	26.28	0.0448	0.1145	0.2352	0.0471	0.0907	1.4735	0.0099	0.4370	0.5836
SNF	86	24.54	0.0282	0.0683	0.1910	0.0343	0.0979	1.3612	0.0106	0.3525	0.7208
SNF	87	26.31	0.0409	0.0770	0.2799	0.0379	0.0815	1.3420	0.0099	0.5054	0.7403
SNF	88	29.72	0.0310	0.0991	0.2096	0.0553	0.0589	1.5681	0.0088	0.3695	0.8019
Ulvalda	83	20.96	0.0243	0.0552	0.1731	0.0226	0.1086	0.9524	0.0124	0.3199	0.5301
Ulvalda	84	16.12	0.0316	0.1013	0.2053	0.0396	0.2051	1.1303	0.0161	0.3745	0.6696
Ulvalda	85	24.35	0.0327	0.0715	0.2083	0.0437	0.1415	1.2190	0.0107	0.4177	0.6820
Ulvalda	86	31.85	0.0208	0.0457	0.1235	0.0472	0.1618	1.5040	0.0082	0.2640	0.8181
Ulvalda	87	24.58	0.0415	0.0785	0.2358	0.0473	0.1888	1.1123	0.0106	0.4906	0.7842
Ulvalda	88	17.37	0.0232	0.0742	0.1574	0.0432	0.3347	1.1281	0.0150	0.2940	0.7293

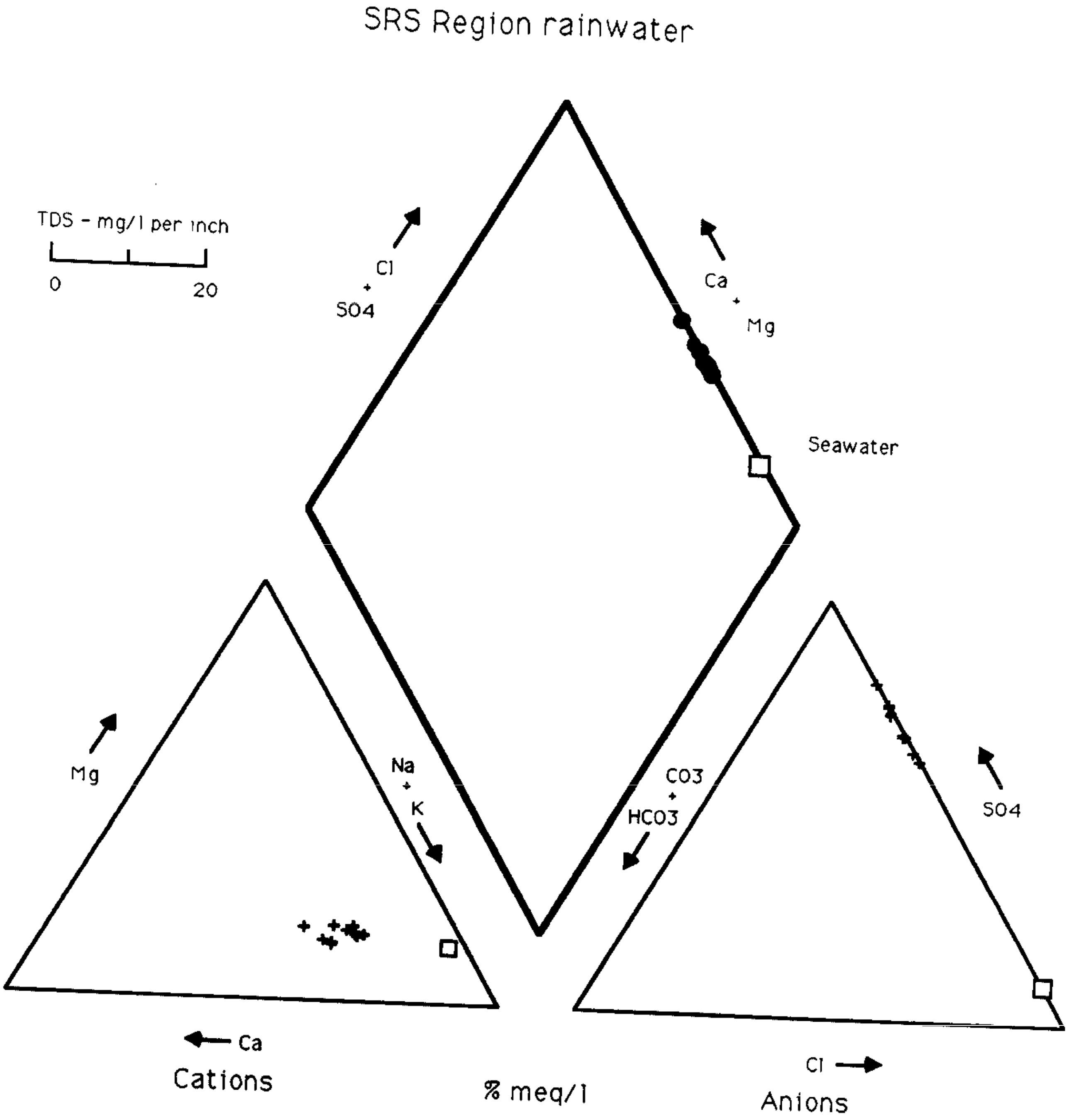


Figure 13. SRS rain water compared to seawater salt ratios. By comparison to sea water, SRS rainwater is enriched in calcium and sulfate. These components are commonly picked up by air masses traveling over land masses, particularly over industrial areas. (See text for explanation of Piper diagrams)

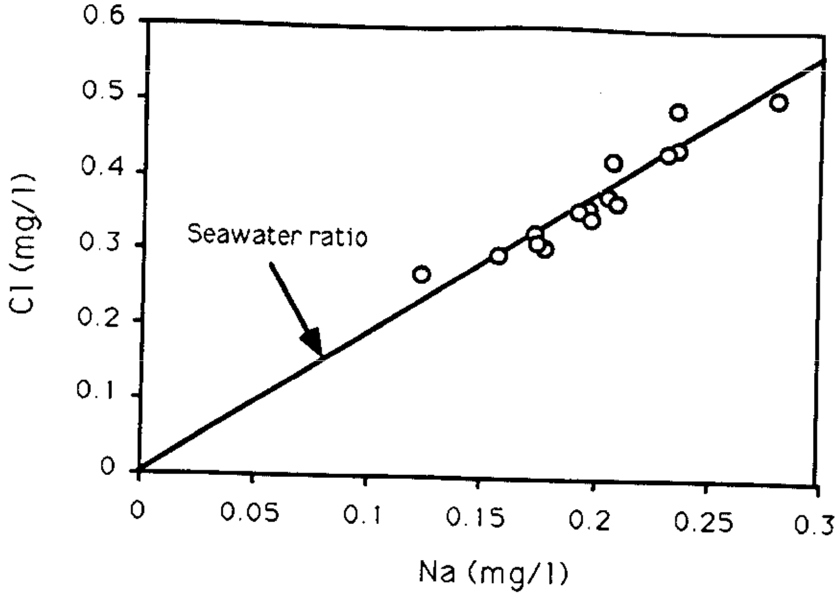


Figure 14. Na vs. Cl in SRS region rainfall. The sodium to cloride ratio closely approximates that of sea water.

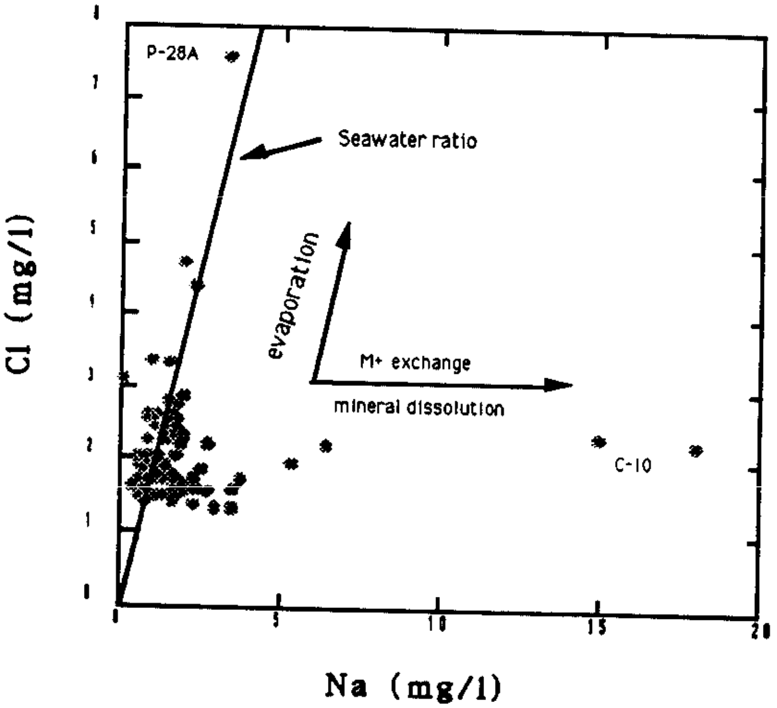


Figure 15. Na:Cl ratios for SRS ground waters has in most instances the same sea values as rainwater. In some instances sodium is considerably higher than would be predicted from the cloride values. Dissolution of silicates and/or cation exchange are the most probable sources for excess sodium.

2) In the figure, a second direction of chemical evolution can be seen. A constant chloride concentration with increasing sodium can be produced by either the dissolution of alkali-bearing silicates, such as feldspar, 2:1 type clays, and zeolites, or by cation exchange processes.

This latter process has been documented in many coastal plain sections (eg. Lee and Strickland, 1988; Speiran and Aucott, 1991). The chemical composition of some of the waters in aquifer units IA and IB seem to have been affected by this natural water-softening process.

Hydrochemical Facies

Within the Coastal Plain sediments sampled during this investigation, the groundwaters, though very dilute, show significant changes in the levels of dissolved oxygen and the redox potential of the water, dissolved trace constituents, and in the major cation and anions present. The latter dissolved ions are frequently used to trace the chemical reactions that occur in the groundwater flow paths from the source or recharge areas down the hydraulic gradients within the aquifers.

Several methods of depicting and analyzing the water quality data have been used for interpreting the data. These include Piper diagrams, Stiff diagrams and Durov plots. Piper diagrams are illustrated in Figure 13. The diagram is used to plot the major cations composition on the lower left trilinear diagram, the major anions composition on the trilinear diagram on the lower right. Sea water composition is plotted as an example on the diagram. By extending lines from the composition points on the trilinear diagrams parallel to the external edges, a common intersection is plotted on the diamond shaped grid. The diameter of the circle at the intersections is proportional to the concentration of total dissolved solids. A good discussion of the piper diagram and comparisons to other means of illustrating the chemical data can be found in Hem (1970).

Back (1966) used Piper diagrams to illustrate and define the concept of hydrochemical facies. This term was used by Back to denote "the diagnostic chemical aspects of ground-water solutions occurring in the hydrologic systems." The classification scheme proposed by Back and used in this discussion is illustrated in Figure 16. When all data from this investigation are plotted together, there are clearly no dominant water types for the site as a whole. However most of the aquifer units, particularly those south of Upper Three Runs, have chemical characteristics that distinguish them from other units on the site.

On the northern edge of the site where there is a single aquifer system (Figure 3), at well clusters P-16 and P-30, the waters are of very low total dissolved solids, less than 20 mg/l, and they contain high concentrations of dissolved oxygen. The waters are acidic, with pHs less than 6.0, and are of mixed water types. That is, there are no predominant cations or anions in the water (Figure 17). The confining units that separate the aquifers are only of only local extent and the hydraulic gradient is downward from the Tertiary formations into the underlying Cretaceous formations over much of this portion of the site (Figure 4). The Cretaceous aquifer receives recharge from Tertiary units where the confining units are thin or absent.

South of this region, where there are two or more aquifer systems, the waters become geochemically distinctive as a result of biogeochemical and geochemical reactions between the water and the sediments and buried organic materials. The waters in both of the aquifers in Aquifer System II have evolved to predominantly calcium-bicarbonate waters (Figures 18 and 19). The evolution to Calcium-bicarbonate waters is most frequently attributed to the dissolution of $CaCO_3$.

Several reaction mechanisms are known to exist for the dissolution reactions. The dissolution by weak carbonic acid;

$$CaCO_3 + H_2CO_3 \dashrightarrow Ca^{2+} + 2HCO_3^-$$

produces two bicarbonate ions per calcium ion whereas the hydrolysis reaction produces a single bicarbonate plus a hydroxyl ion.

$$CaCO_3 + H_2O \dashrightarrow Ca^{2+} + HCO_3^- + OH^-.$$

In either case, equal amounts of alkalinity are produced by the reaction so that the bicarbonate concentration calculated from alkalinity data in this study are

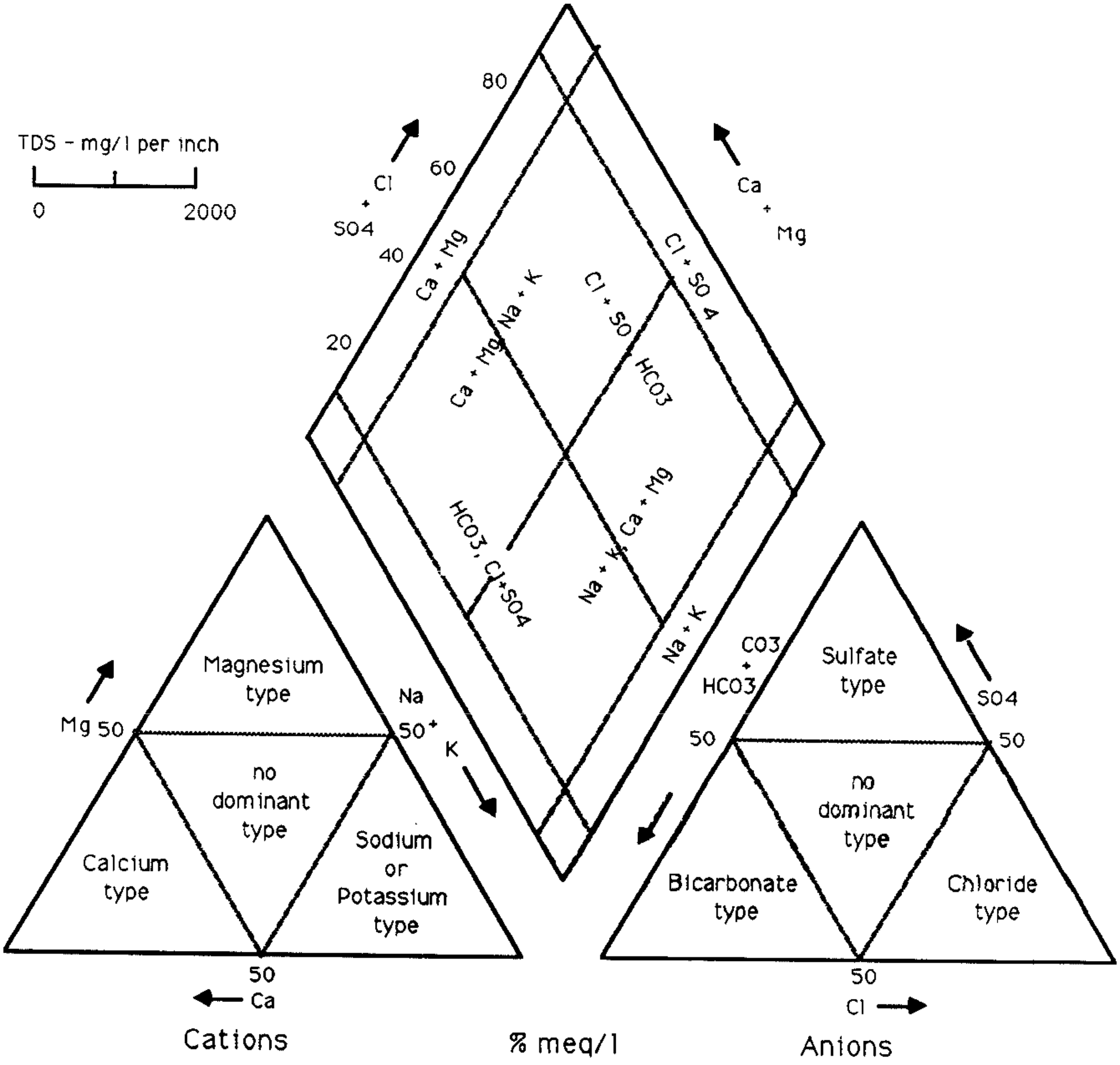


Figure 16. Hydrochemical facies diagram (after Back, 1966). See text for explanation of Piper diagram.

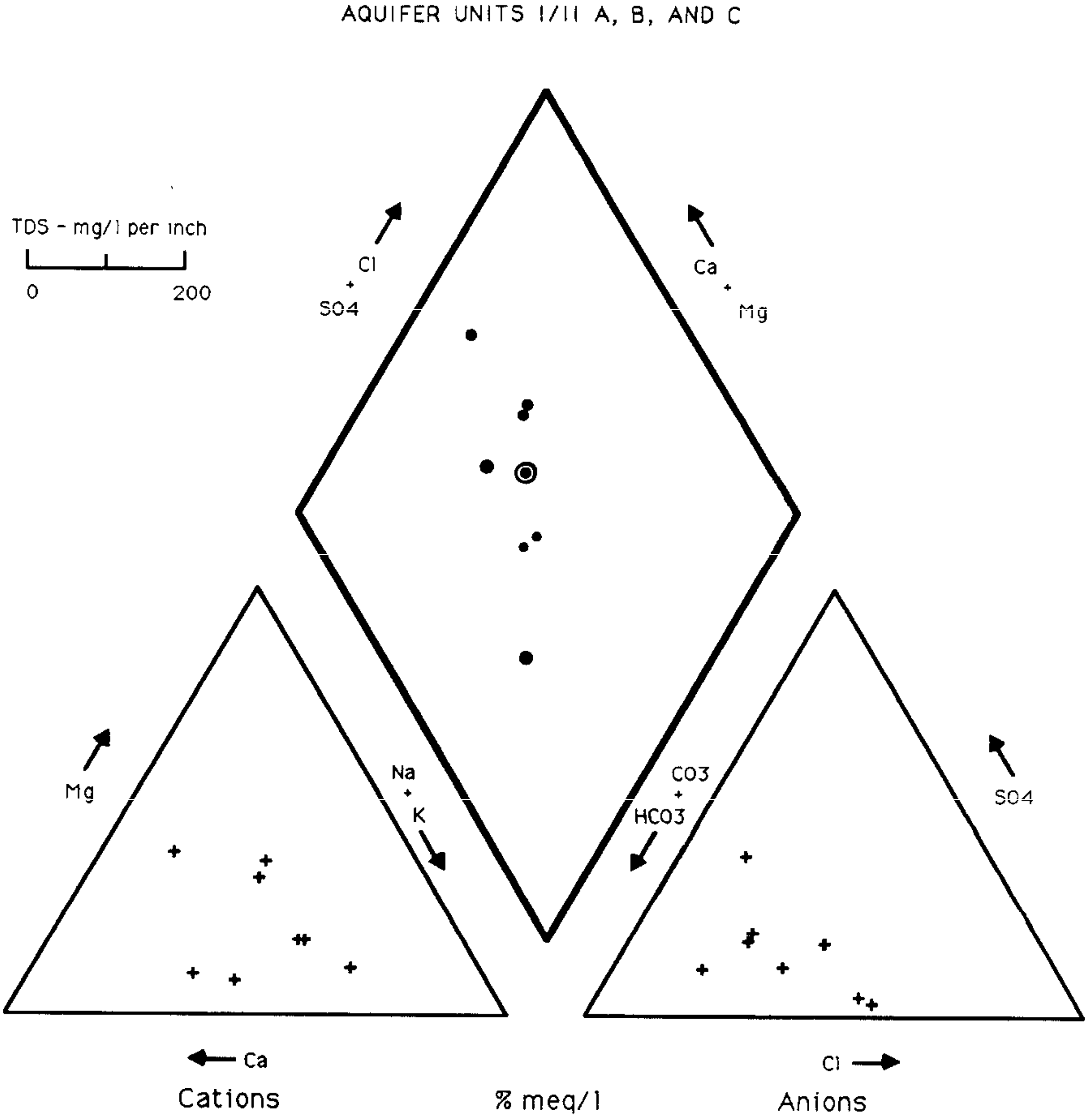


Figure 17. Piper diagram illustrating composition of ground waters in Aquifer System I/II.

AQUIFER UNIT IIB

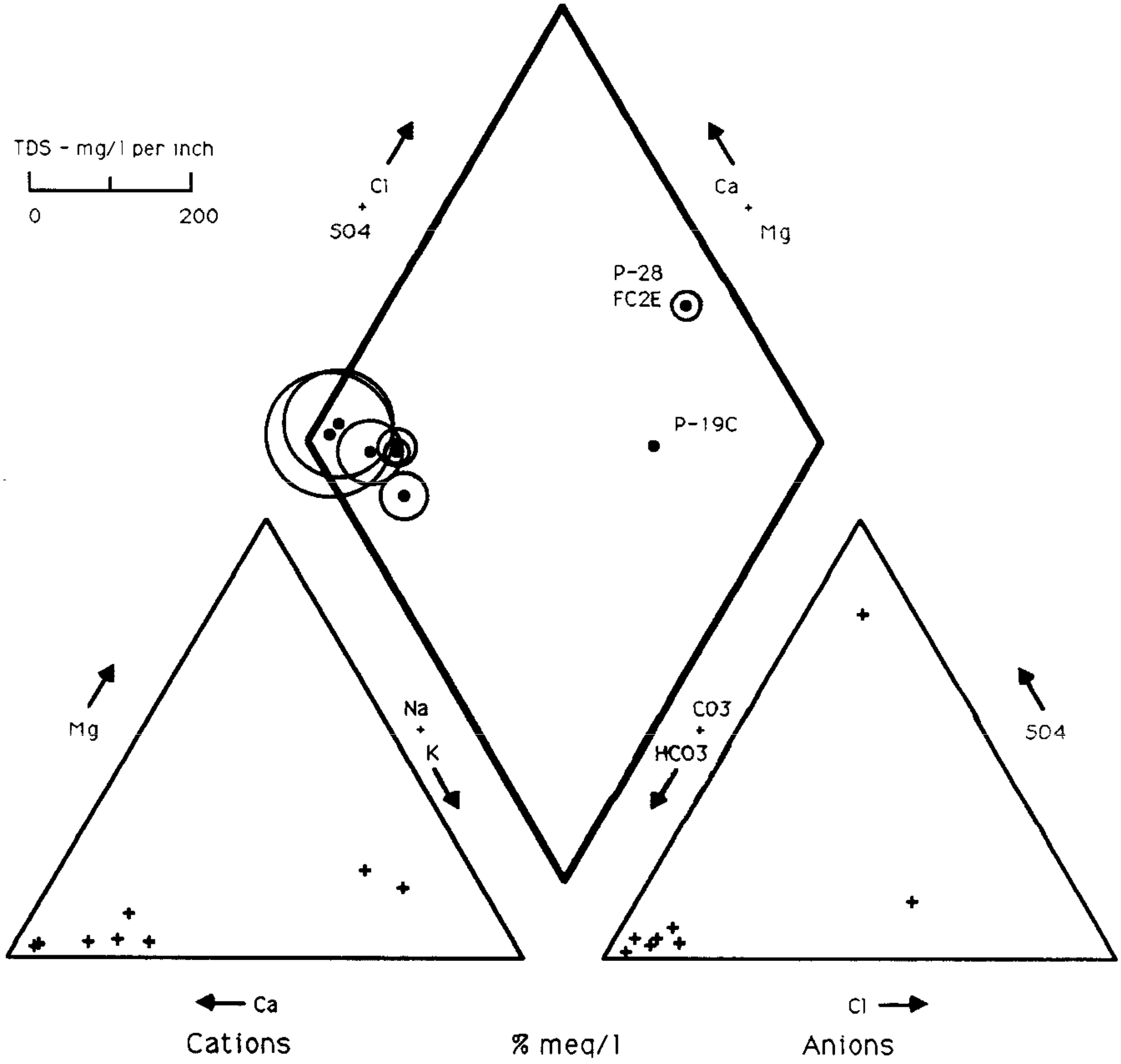


Figure 18. Piper diagram illustration the composition of ground waters in Aquifer IIB.

not useful indicators to distinguish the reaction mechanisms. It is probable that both reactions contribute in the Tertiary aquifers. There have not been sufficient ^{13}C isotopic data on these aquifer units or direct measurement of dissolved inorganic carbon to generalize at the present time.

The samples from monitoring wells screened in the Tertiary section at the P-19 well site cluster are anomalous in their water chemistry. At this site, which is located close to the Pen Branch Fault, samples from wells set in Aquifer Units IIA and IIB are low in total dissolved solids and show no evidence of having had opportunity to react with carbonates. Limestones, marls, and clay units are conspicuously absent from the Tertiary section at this locality (Bledsoe, 1986) and high vertical permeabilities would not be unexpected.

The Cretaceous aquifers south of Upper Three Runs Creek have a somewhat more complex chemistry. Examination of the Piper diagrams for these units (Figures 20 and 21) shows a marked evolution from sulfate-rich waters at low total dissolved solids toward bicarbonate-rich waters at higher TDS. The evolution toward calcium-rich waters is not as pronounced as in the Tertiary units. Alkalies (Na+K) are major contributors to the cation compositions and the waters would be classified as mixed water types or $Na+K-HCO_3$ waters by Back's classification system. The reaction pathways toward these compositions are fairly complex and not well understood at present.

The calcium in these waters may be derived from several sources including dissolution of gypsum from confining beds such as the Ellenton Formation, the dissolution of calcite or calcium plagioclase or possibly, displacement of calcium by potassium in cation exchange reactions. The alkalies in the Cretaceous aquifer waters are primarily derived from the breakdown of silicate minerals including feldspars, mica, and various clay minerals including illite.

There is no consistent trend in the proportion of potassium to sodium in the waters as total dissolved solids increases (Figure 22). Because potassium is usually the most tightly bound ion in cation exchange reactions, its relative abundance in the samples from aquifer units IA and IB suggests that cation exchange has not played a dominant role in the evolution of these waters. The

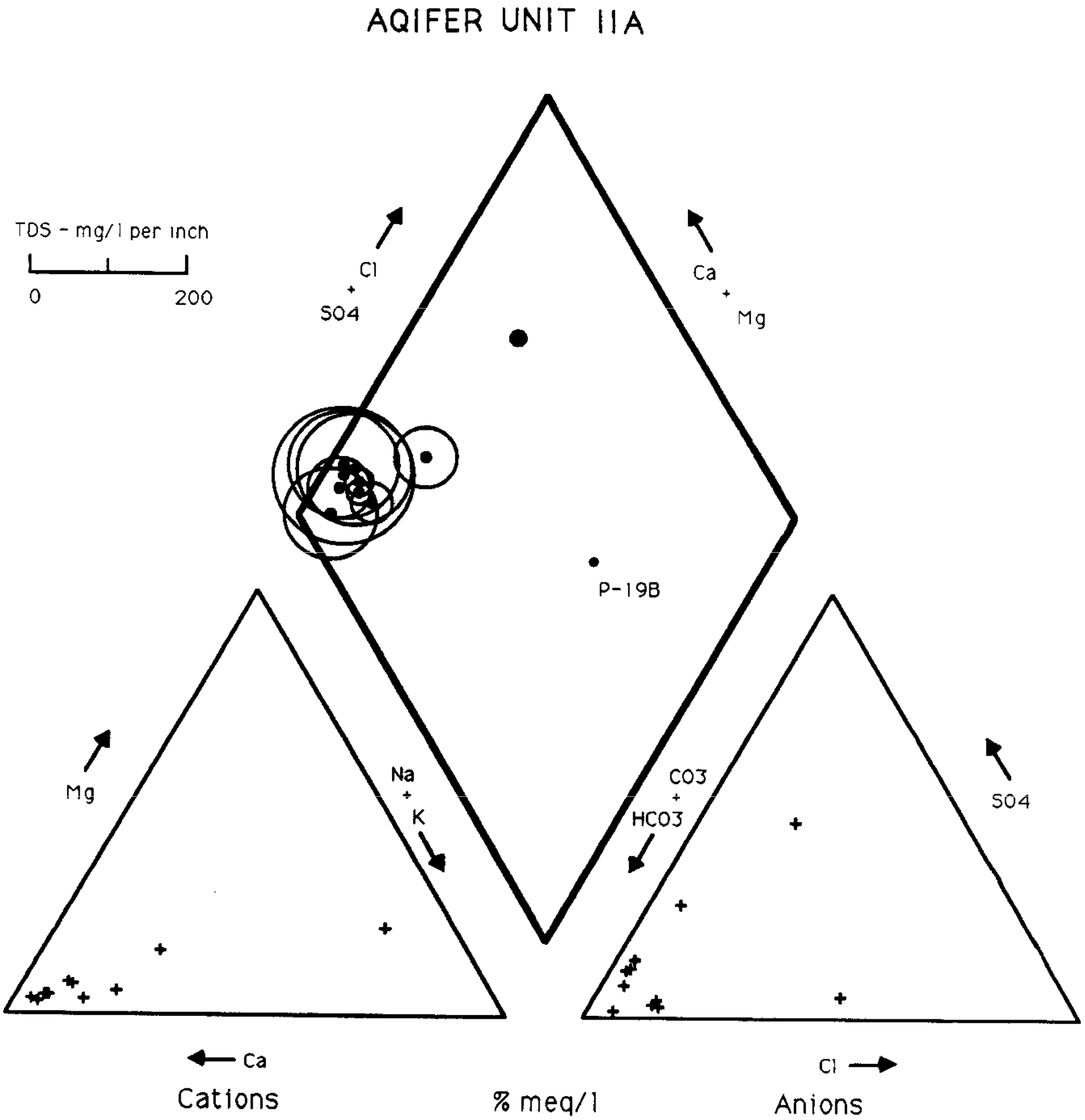


Figure 19. Piper diagram illustrating the composition of Aquifer Unit IIA.

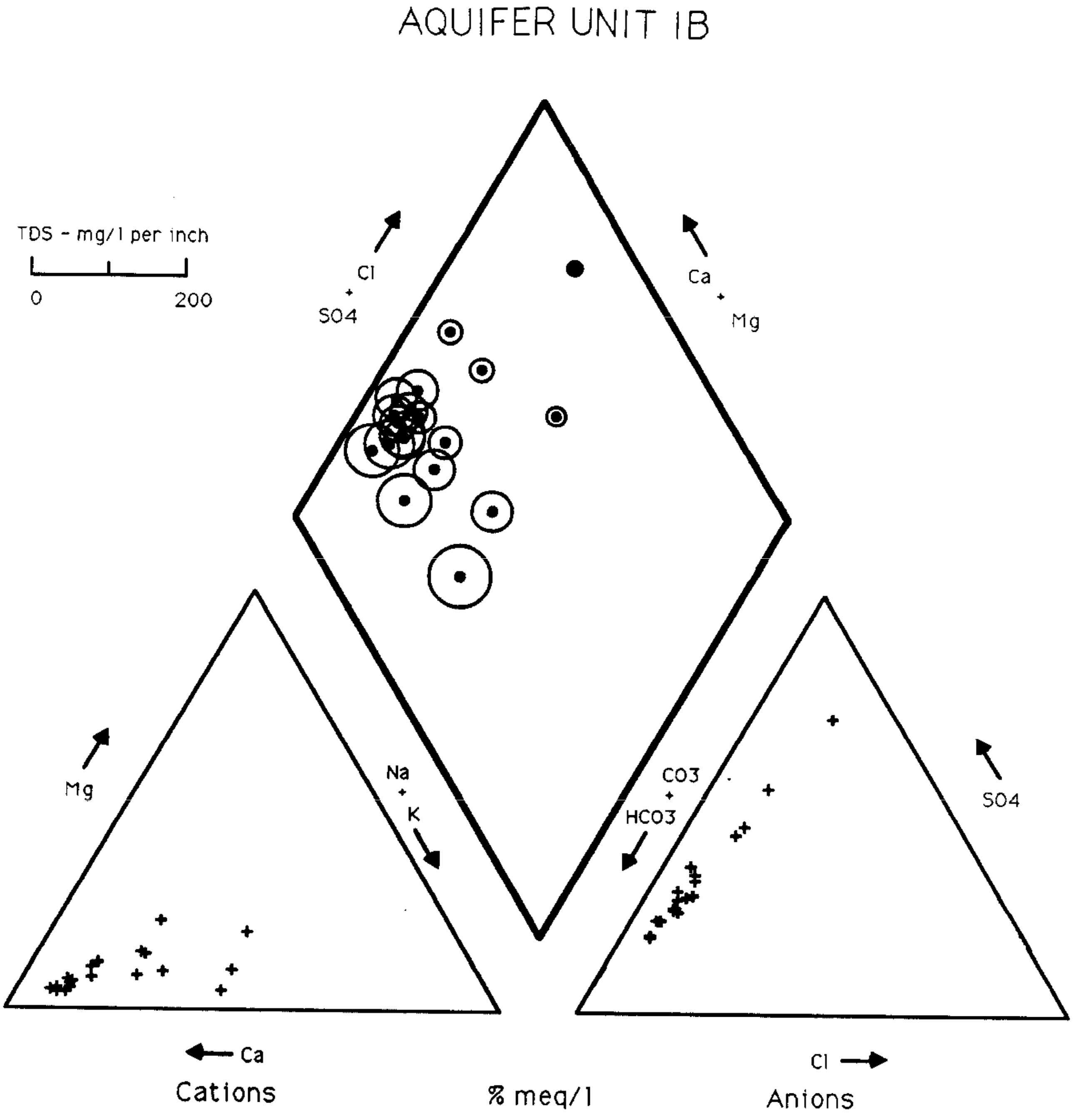


Figure 20. Piper diagram illustrating the composition of ground water in Aquifer Unit IB.

AQUIFER UNIT IA

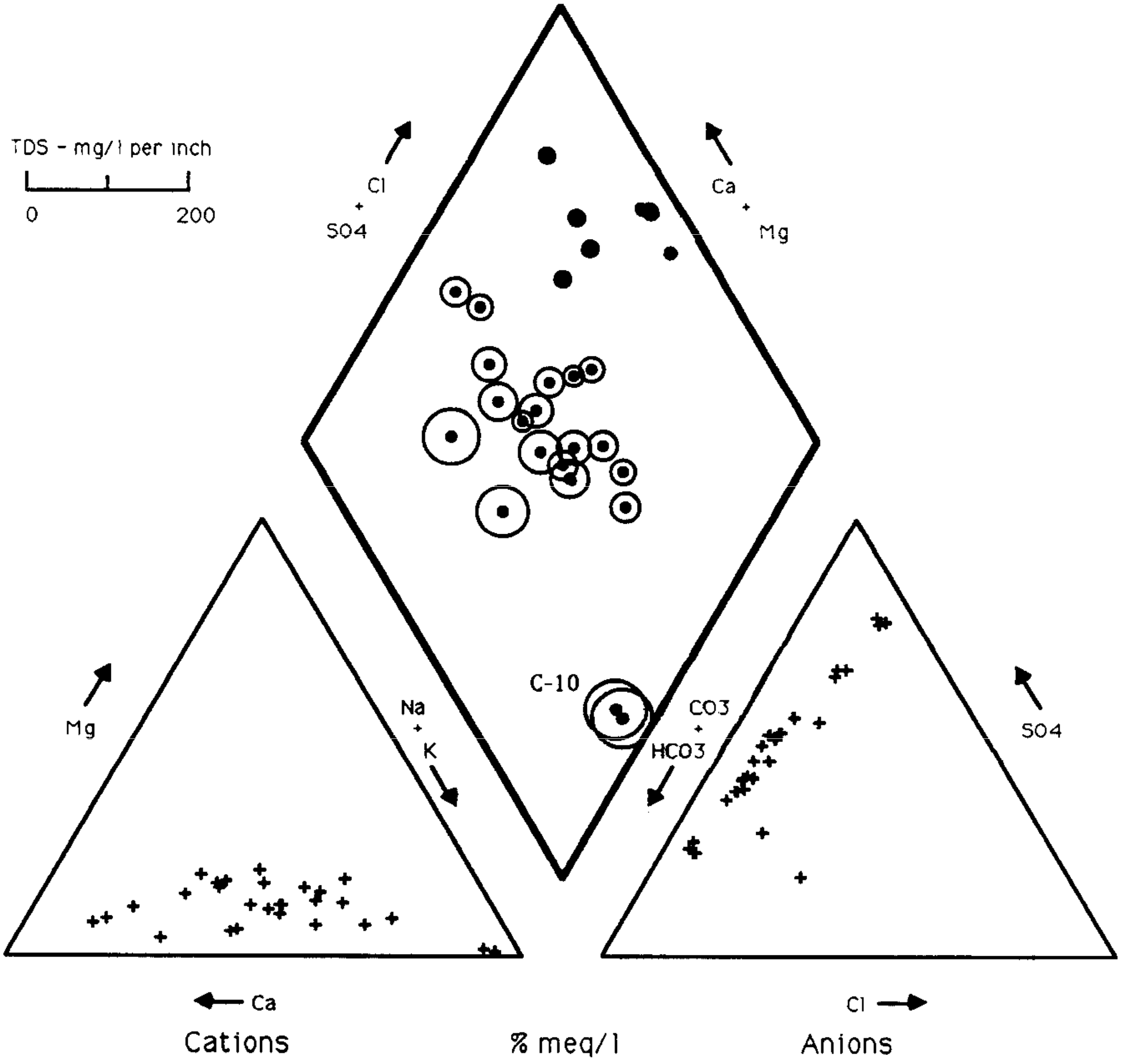


Figure 21. Piper diagram illustrating the composition of Aquifer Unit IA. The chemical composition of C-10 has been modified by cation exchange reactions.

exceptions are the samples from well C-10 where sodium is clearly the dominant cation. In this down-gradient locality south of the Savannah River Site, cation exchange processes have led to water conditions comparable to those formed by exchange processes observed in other regions of the South Carolina Coastal Plain (eg. Speiran and Aucott, 1991).

Increases in the HCO_3^- concentration is apparently largely through the microbial oxidation of lignite within the aquifers (Murphy *et al.*, in press). The del ^{13}C signatures of the water are typically light; in the range of -20 $^{o}/oo$ to -25 $^{o}/oo$. Usually these light values indicate an organic source of carbon rather than the dissolution of limestone or other bicarbonate ion source. Waters that have reacted with calcium carbonate minerals by either of the reactions above are usually enriched in ^{13}C and have del ^{13}C values closer to the Peedee belemnite standard (del $^{13}C = 0\ ^{o}/oo$). Anomalous values are widely reported in the literature however (Faure, 1986) and recrystallization of calcite, such as has occurred to carbonates observed at the Savannah River Site, can alter the isotopic composition of the carbonate minerals.

Dissolved oxygen is less than 0.1 mg/l for most of the samples from this aquifer system (Aquifer System I). From Upper Three Runs Creek southward, the aquifers in this system are anaerobic and contain abundant dissolved iron (Appendix III, table 3). The iron content in these aquifers is undesirably high, usually between 1 and 5 mg/l. The anaerobic conditions allow the dissolved iron to remain in the ferrous form but have not become reducing to the extent that sulfate has been reduced to the sulfide form.

Chapelle and Lovley (1992) have described a high-iron groundwater zone in the Middendorf Aquifer, approximately 25 miles wide, that extends across South Carolina from the Savannah River Site to North Carolina approximately paralleling the Fall Line. This high iron zone is inferred to result from the reduction of iron oxyhydroxide grain coating by bacteria during the oxidation of organic matter within the confined zones of the aquifer. The authors propose that the activity of the iron-reducing bacteria inhibit the activity of sulfate-reducing bacteria. Sulfate reduction begins further down gradient after the more easily oxidized organics have been consumed. These observations are consistent with the observed high-iron zones in Aquifer Units IA and IB and with the general chemistry of the waters.

Groundwater Age Dating

In spite of the ambiguities and uncertainties associated with the chemical evolution of the Savannah River Site ground water, carbon-14 age dates of selected water samples have been computed by Pacific Northwest Laboratories (Schramke *et al.*, 1991). Reaction path modelling was undertaken using the PHREEQE computer code (Parkhurst *et al.* 1980) and the CSOTOP subroutine (Cheng and Long, 1984). The results provide reasonable approximations of groundwater ages and flow velocities. The calculated ages, based on the modelling results are given in table 3 In general, these age dates agree reasonable well with expected values based on distance from recharge areas and the hydraulic conductivities of the aquifer units (Murphy *et al.*, in press).

Table 3 Calculated ages for selected groundwater samples.

Sample	fmc(1)	Calculated ages (2)	Calculated ages (3)
Aquifer Unit IA			
P-24TA	0.3669	6,910-7,567	6,900
P-28TA	0.7717	755-921	750
P-29TA	0.8080	0 - 519	modern
C-5	0.5183	3,577	
C-10	0.1110	11,460	11,500
Aquifer Unit IIA			
P-21A	0.3182	6,692	
P-27B	0.7708	1,826	

(1) fraction modern carbon.
(2) Schramke *et al.*, 1991.
(3) Murphy *et al.*, *in press*.

SUMMARY AND CONCLUSIONS

The mineralogical and chemical investigations undertaken as part of the Savannah River Baseline Hydrogeologic Investigation have provided an extensive set of background data and information on the geochemistry of the major aquifer units at the site. In spite of the analytical difficulties associated with analysis of very low concentrations of solutes, the data from the principal aquifer units show clear trends in evolution of the water chemistry in down gradient directions.

North of Upper Three Runs Creek, where the principal confining units have become thin and discontinuous, the waters are low in total dissolved solids and are not chemically differentiated. Local recharge to the Cretaceous units is evident in the data. South of Upper Three Runs Creek, the water quality in the Tertiary units is primarily controlled by dissolution of calcium carbonate. The aquifers in the Cretaceous section have a more complex chemistry. The primary source of bicarbonate appears to be oxidation of organic matter, principally lignite. Reduction of iron from the ferric (Fe^{3+}) to the ferrous (Fe^{2+}) form occurs in these anaerobic environments and produces undesirably high values of dissolved iron in these aquifers. Sulfate reduction does not appear to be a significant process however.

The major cations in aquifer units IA and IB appear to be primarily derived from dissolution of silicate minerals, possibly accompanied by a limit degree of cation exchange. The latter process is evident only in well C-10 to the southeast of the Savannah River Site.

Carbon-14 age dating of the water by Pacific Northwest Laboratories has provided some ages dates on selected samples. The dates indicate water velocities consistent with the Darcy velocities calculated from hydraulic characteristics of the units. The carbon-14 dates obtained from this study are still tentative considering the lack of constraint on the isotopic dilution effects of oxidation of organics and the dissolution of carbonate minerals.

Modelling and prediction of groundwater reactions could be significantly improved in future studies by:

1) Using direct determination of dissolved inorganic carbon rather than calculating this value from alkalinity titrations,

2) sulfur isotope analysis of dissolved sulfate and of pyrite, gypsum, and organic sulfur from the principal hydrogeologic units, and

3) determination of the carbon isotopic composition of the recrystallized calcium carbonate materials in the Tertiary units.

REFERENCES

Aaland, R.K. and H. W. Bledsoe, 1990, *Classification of Hydrostratigraphic Units at Savannah River Site, South Carolina (U)*, WSRC-RP-90-987, 15 pp."

Back, William, 1966, *Hydrochemical Facies and Ground-water Flow Patterns in Northern Part of Atlantic Coastal Plain*, U.S.G.S. Professional Paper 498-A

Bledsoe, H.W.,1984, *SRP Baseline Hydrogeologic Investigation - Phase I*, DPST - 84-833, E.I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC.

Bledsoe, H.W., 1987, *SRP Baseline Hydrogeologic Investigation - Phase II*, DPST-87-674, E.I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC.

Bledsoe, H.W.,1988, *SRP Baseline Hydrogeologic Investigation - Phase III*, DPST-88-627, E.I. duPont de Nemours & Co., Savannah River Laboratory, Aiken, SC,

Bledsoe, H.W., R.K. Aadland, and K.A. Sargent, 1990, *SRS Baseline Hydrogeologic Investigation - Summary Report (U)*, Westinghouse Savannah River Co., Aiken, SC, WSRC-RP-90-1010, app. 200pp.

Brown, P.M., D.L. Brown, M.S. Reid, and D.B. Lloyd, Jr., 1979, *Evaluation of the geologic and hydrologic factors related to the waste storage potential of Mesozoic aquifers in the southern part ofthe Atlantic Coastal Plain, South Carolina and Georgia*, U.S. Geol. Surv. Prof. Pap., 1088, 33p.

Chapelle, F.H. and Lovley, D.R., 1991, *Competitive exclusion of sulfate reduction by F(III)-reducing bacteria: a mechanishm for producing discrete zones of high-iron ground water*, Ground Water, v. 30, no.1, p.29-36.

Cheng, S.L., and A. Long, 1984, *Implementation of a carbon isotope subroutine to the computer program PHREEQE and the application to 14C ground-water dating*, Hydrology and Water Resources of Arizona and the Southwest, v.14

Proc. of the 1984 meetings of the Arizona Section, American Water Resources Association and the Hydrology Section, Arizona-Nevada Academy of Science, pp. 121-135.

Christensen, E.J.,and D.E.Gordon, 1983, *Technical summary of groundwater quality protection program at Savannah River Plant, Volume 1*, Technical Report DPST-83-829, 518p.

Gelting, J., 1990, *X-ray diffraction of selected samples from deep test wells in Allendale, Aiken, and Barnmell Counties, South Carolina*, ESRI Technical Report 90-05-G103, South Carolina Water Resources Commission, Columbia, South Carolina.

Craig, H.L, 1961, *Isotopic variation in meteoric waters*, Science, v. 133, pp. 1702-1703.

Fallaw, W.C., 1990, *Subsurface Stratigraph and Structure of A/M Area at the Savannah River Site, Aiken County, South Carolina*, Camp Dresser & McKee, (in Review), ca. 60 pp.

Faure, G., 1986, *Principles of Isotope Geology*, 2nd ed., New York, John Wiley and Sons, 589 pp.

Gohn, G.S., 1988, *Late Mesozoic and Early Cenozoic Geology of the Atlantic Coastal Plains; North Carolina to Florida, in,* Sheridan, R.E., and Grow, J.A., eds., *The Geology of North America*, v.1-2, Geol.Soc. Am., p.107-130.

Hardegree, W.S., 1990, *Separating Stream Flow from Savannah River Backwater and Ground water by Means of Oxygen-18*, MS Thesis, University of Georgia, Athens, Georgia, 98 pp.

Hem, J.D., 1970, *Study and Interpretation of the Chemical Characteristics of Natural Water*, U.S.G.S. Water-Supply Paper 1473, 363 pp.

Hubbard, J.E., Stephenson, J.L. Steele, and D.E. Gordon, 1988, *Water Resource Management Planning Guide for Savannah River Plant*, E.I. duPont de Nemours & Co., Savannah River Laboratory, Aiken, SC, DPST-88-835, 32 pp.

Hydrolab Corporation, 1986, *Hydrolab Datasonde I Operating Manual*, Hydrolab Inc., Austin, TX.

Kuntz, G.B. and W.T. Griffin, 1988, *Hydrogeologic investigation and establishment of a permanent multi-observation well network in Aiken, Allendale, and Barnwell counties, South Cartoline-phase II*, State of South Carolina Water Resources Commission, open file report no. 28

Kuntz, G.B., W.T. Griffin, T. Greaney, and J.A. Gellici, 1989, *Hydrogeologic Investigation and Establishment of a Permanent Multi-Observational Well Network in Aiken, Allendale, and Barnwell Counties South Carolina-- Phase III*, State of South Carolina Water Resources Commission, Open-File Report No. 32

Lee, R.W., and D.J. Strickland, 1988, *Geochemistry of ground-water in Tertialry and Crecaceous sediments of the southeastrern coastal Plain in Eastern Georgia, South Carolina, and southeastern North Carolina*, Water Resources Research, v 24, pp. 291-303.

Logan, W.R., 1987, *Geohydrologic Investigation and Establishment of a Permanent Multi-observational Well Network in Aiken, Allendale, and Barwell Counties South Carolina - phase I*, State of South Carolina Water Resources Commission open-file report No. 23.

Looney, B.B., H.W. Bledsoe, Jr., V. Price, Jr., J.S. Haselow, D.S. Kaback, R.L. Nichols, D.E. Stephenson, R.K. Aadland, A.L. Stieve, C.A. Eddy, and T.C. Hazen, 1990, *New Production Reactor Environmental Impact Statement Background Data: Recent Measurements of Groundwater Elevations in the water Bearing Zones underlying the Savannah River Site: 1988 (U)*, Westinghouse Savannah River Co., WSRC-TR-90-5, 16pp.

Marine, I.W., 1967, *The permeability of fractured crystalline rock at the Savannah River Plant near Aiken, South Carolina*, U.S.G.S. Prof. Paper 575-B, B203-B211.

Marine, I.W., 1974, *Geohydrology of the buried Triassic basin at the Savannah River Plant*, South Carolina, Am. Assoc. Petrol. Geol. Bull., v. 58, p. 1825.

Marine, I.W., 1976, *Geochemistry of Ground Water at the Savannah River Plant.*

Marine, I.W., and Siple, G.E., 1974, *Buried Triassic basin in central Savannah River area, South Carolina and Georgia*, Geol. Soc. Am. Bull., v.85, p.311-320.

Murphy, E.M., J.A. Schramke, J.K. Fredrickson, H.W. Bledsoe, A.J. Francis, D.S. Sklarew, J.C. Linehan, ____, *The influence of microbial activity and sedimentary organic carbon on the isotope geochemistry of the Middendorf Aquifer*, Water Resources Research, in press.

Parkhurst, D.L., D.C. Thorstenson, and L.N. Plummer, 1980, *PHREEQE- a Computer Program for Geochemical Calculations*, U.S. Geol. Survey Water Resources Investigation 80-96.

Schramke, J.A., E.M. Murphy, and B.D. Wood, 1991, Geochemical and carbon isotope modelling of ground water from the Savannah River Site. letter report to Environmental Sciences Section, Savannah River Laboratories. Pacific Northwest Laboratiories, 132 pp.

Siple, G.E., 1967, *Geology and Ground Water of the Savannah River Plant and vicinity, South Carolina*, U.S. Geological Survey Water Supply Paper 1841, U.S. Government Printing Office, Washington, D.C.

Speiran, G.K., and W.R. Aucott, 1991, *Effects of Sediment Depositional Environment and Ground-water Flow on the Quality and Geochemistry of Water in Aquifers in Sediments of Cretaceous Age in the Coastal Plain of South Carolina*, U.S. Geological Survey, Open-File Report 91-202, 79 pp.

Strom, R.N. and D.S. Kaback, 1990, *Tritium in A/M area ground water (U)*, Westinghouse Savannah River Co., Aiken SC, WSRC-TR-92-8, app. 20pp.

Wenner, D.B., P.D. Ketcham, and J.F. Dowd, 1991, *Stable isotopic composition of waters in a small Piedmont watershed,* in Taylor, H.P., J.R. O'Niel and I.R. Kaplan (eds.), Stable Isotope Geochemistry, The Geochemical Society, Special Publication No. 3, pp. 195-203.

Appendix I. Well Data

WELL CLUSTER	WELL NO.	Well Location SRS Coordinates N	 E	 N Lat.	 E Long.	mid-screen elevation (ft)	mid-screen depth (ft)	Stratigraphic Interval(1)	Hydrostatigraphic Unit
P13	**P13C**	35600	60000	33.20	81.58	38	-215	McBean	IIB
P13	**P13A**	"	"	"	"	-63	-316	Congaree	IIA
P13	**P13TD**	"	"	"	"	-182	-435	Peedee	IB
P13	**P13TC**	"	"	"	"	-382	-635	Black Creek	IB
P13	**P13TA**	"	"	"	"	-667	-920	Middendorf	IA
P14	**IDB-IC**	72445	76440	33.31	81.61	203	-91	McBean	WT
P14	**P14C**	"	"	"	"	143	-151	McBean	IIB
P14	**P14TC**	"	"	"	"	-202	-496	Black Creek	IB
P14	**P14TB**	"	"	"	"	-267	-561	Black Creek	IB
P14	**P14TA**	"	"	"	"	-536	-830	Middendorf	IA
P15	**P15A**	47008	50864	33.21	81.62	-92	-345	Ellenton	IIA
P15	**P15TC**	"	"	"	"	-362	-615	Black Creek	CIA-IB
P15	**P15TB**	"	"	"	"	-462	-715	Black Creek	IA
P15	**P15TA**	"	"	"	"	-628	-881	Middendorf	IA
P16	**P16B**	98222	82318	33.38	81.64	186	-74	McBean	I/IIC
P16	**P16A**	"	"	"	"	126	-134	Congaree	I/IIC
P16	**P16TC**	"	"	"	"	-125	-385	Black Creek	I/IIB
P16	**P16TB**	"	"	"	"	-189	-449	Black Creek	I/IIA
P16	**P16TA**	"	"	"	"	-354	-614	Middendorf	I/IIA
P17	**P17A**	63199	109791	33.34	81.50	37	-295	Williamsburg	IIA
P17	**P17TD**	"	"	"	"	-73	-405	Peedee	CI-II
P17	**P17TC**	"	"	"	"	-283	-615	Black Creek	IB
P17	**P17TB**	"	"	"	"	-363	-695	Black Creek	IA
P17	**P17TA**	"	"	"	"	-522	-854	Middendorf	IA
P18	**P18A**	67579	47653	33.25	81.67	16	-280	Williamsburg	CI-II
P18	**P18TD**	"	"	"	"	-185	-481	Peedee	IB
P18	**P18TC**	"	"	"	"	-263	-559	Black Creek	IB
P18	**P18TB**	"	"	"	"	-375	-671	Black Creek	IA
P18	**P18TA**	"	"	"	"	-544	-840	Middendorf	IA

Appendix I. Well Data

WELL CLUSTER	WELL NO.	Well Location SRS Coordinates				mid-screen elevation (ft)	mid-screen depth (ft)	Stratigraphic Interval(1)	Hydrostatigraphic Unit
		N	E	N Lat.	E Long.				
P19	**P19D**	55296	60035	33.25	81.62	262	-35	Upland	WT
P19	**P19C**	"	"	"	"	120	-177	McBean	IIB
P19	**P19B**	"	"	"	"	68	-229	Congaree	IIA
P19	**P19TD**	"	"	"	"	-133	-430	Peedee	CI-II
P19	**P19TA**	"	"	"	"	-464	-761	Middendorf	IA
P19	**P10A**	"	"	"	"	-549	-846	Middendorf	IA
P20	**P20C**	56094	76768	33.28	81.57	142	-145	Dry Branch	IIB
P20	**P20B**	"	"	"	"	38	-249	Congaree	IIA
P20	**P20TD**	"	"	"	"	-273	-560	Peedee	IB
P21	**P21D**	24675	40617	33.14	81.61	137	-70	Tobacco Road	WT
P21	**P21B**	"	"	"	"	-77	-284	Congaree	IIA
P21	**P21A**	"	"	"	"	-150	-357	Williamsburg	CI-II
P21	**P21TD**	"	"	"	"	-273	-480	Peedee	IB
P21	**P21TC**	"	"	"	"	-466	-673	Black Creek	IB
P21	**P21TB**	"	"	"	"	-604	-811	Black Creek	IA
P21	**P5A**	"	"	"	"	-772	-979	Middendorf	IA
P22	**P22D**	20593	73555	33.19	81.51	165	-50	Tobacco Road	WT
P22	**P22C**	"	"	"	"	84	-131	Dry Branch	CIIA-IIB
P22	**P22TD**	"	"	"	"	-314	-529	Peedee	IB
P22	**P22TC**	"	"	"	"	-421	-636	Black Creek	IB
P22	**P22TA**	"	"	"	"	-725	-940	Middendorf	IA
P23	**P23B**	48063	30931	33.18	81.68	46	-135	Congaree	IIA
P23	**P23A**	"	"	"	"	-31	-212	Williamsburg	CI-II
P23	**P23TD**	"	"	"	"	-232	-413	Peedee	IB
P23	**P23TC**	"	"	"	"	-402	-583	Black Creek	IB
P23	**P23TB**	"	"	"	"	-511	-692	Black Creek	IA
P23	**P23TA**	"	"	"	"	-626	-807	Middendorf	IA
P24	**P24D**	43096	66565	33.23	81.58	258	-55	Upland	WT

Appendix I. Well Data

WELL CLUSTER	WELL NO.	Well Location SRS Coordinates N	E	N Lat.	E Long.	mid-screen elevation (ft)	mid-screen depth (ft)	Stratigraphic Interval(1)	Hydrostatigraphic Unit
P24	**P24C**	"	"	"	"	168	-145	Dry Branch	IIB
P24	**P24TD**	"	"	"	"	-182	-495	Peedee	IB
P24	**P24TC**	"	"	"	"	-276	-589	Peedee	IB
P24	**P24TB**	"	"	"	"	-487	-800	Black Creek	IA
P24	**P24TA**	"	"	"	"	-648	-961	Middendorf	IA
P25	**P25C**	52494	42261	33.21	81.66	105	-160	Dry Branch	IIB
P25	**P25A**	"	"	"	"	-39	-304	Ellenton	CI-II
P25	**P25TE**	"	"	"	"	-140	-405	Peedee	CI-II
P25	**P25TD**	"	"	"	"	-200	-465	Peedee	IB
P25	**P25TB**	"	"	"	"	-460	-725	Black Creek	IA
P25	**P25TA**	"	"	"	"	-594	-859	Middendorf	IA
P26	**P26D**	71959	18052	33.21	81.76	111	-40	McBean	WT
P26	**P26B**	"	"	"	"	76	-75	McBean	CIIA-IIB
P26	**P26A**	"	"	"	"	26	-125	Congaree	IIA
P26	**P26TD**	"	"	"	"	-94	-245	Peedee	IB
P26	**P26TB**	"	"	"	"	-378	-529	Black Creek	IA
P26	**P26TA**	"	"	"	"	-533	-684	Middendorf	IA
P27	**P27D**	70382	64023	33.28	81.63	209	-65	Dry Branch	WT
P27	**P27C**	"	"	"	"	142	-132	Dry Branch	IIB
P27	**P27B**	"	"	"	"	84	-190	Congaree	IIA
P27	**P27TC**	"	"	"	"	-291	-565	Black Creek	IB
P27	**P27TA**	"	"	"	"	-538	-812	Middendorf	IA
P28	**FC2E**	79284	55441	33.29	81.67	192	-95	Dry Branch	IIB
P28	**FC2D**	"	"	"	"	162	-125	McBean	CIIA-IIB
P28	**FC2A**	"	"	"	"	55	-232	Williamsburg	CI-II
P28	**P28A**	"	"	"	"	-52	-334	Peedee	CI-II
P28	**P28TE**	"	"	"	"	-129	-411	Peedee	IB
P28	**P28TB**	"	"	"	"	-347	-629	Black Creek	IA
P28	**P28TA**	"	"	"	"	-478	-760	Middendorf	IA

Appendix I. Well Data

WELL CLUSTER	WELL NO.	Well Location SRS Coordinates				mid-screen elevation (ft)	mid-screen depth (ft)	Stratigraphic interval(1)	Hydrostatigraphic Unit
		N	E	N Lat.	E Long.				
P29	**P29D**	86483	42796	33.29	81.72	163	-102	Dry Branch	WT
P29	**P29C**	"	"	"	"	131	-134	Congaree	I/IIC
P29	**P29B**	"	"	"	"	72	-193	Congaree	I/IIC
P29	**P29A**	"	"	"	"	-44	-309	Peedee	CI-II
P29	**P29TC**	"	"	"	"	-234	-499	Black Creek	CIA-IB
P29	**P29TA**	"	"	"	"	-414	-679	Middendorf	IA
P30	**P30TA**	98933	57105	33.34	81.71	-340	-694	Middendorf	I/IIA
MISC	**C2**	139437	63530	33.43	81.77	-105			I/IIA
MISC	**C-3**	118152	165110	33.54	81.48	-193			I/IIA
MISC	**C-5**	39414	127403	33.32	81.40	-572			CI
MISC	**C-6**	-19039	119608	33.18	81.31	-830			IA
MISC	**905-94K**	53298	41687	33.21	81.66	?			
MISC	**MR-H**	198432	107998	33.68	81.77	?			I/II
MISC	**FMC-K**	187786	131444	33.66	81.68	315			I/II
MISC	**EL-H**	215412	117183	33.69	81.78	?			I/II
MISC	**DI-K**	192246	114211	33.64	81.74	310			I/II
MISC	**C10**	-515557	69610	33.03	81.38	-1120			IA
MISC	**CW-1**	127964	211062	33.65	81.36	130			I/II
MISC	**CA-1**	154883	86846	33.51	81.74	106			I/II

(1) Stratigraphic intervals from Bledsoe (1984, 1987,1988).

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
13	33	Upland	37	1		59	3								
13	44	Upland	68			30	2								
13	218	McBean	71	2	2	23	2								
13	254	Congaree	94		1	5	0.05								
13	327	Congaree	35	0.05	0.05	64	1								
13	390	Ellenton	30	0.05	4	58	9								
13	422	Ellenton	21		5	61	6	7							
13	434	Peedee	35	1		64									
13	636	Black Creek	95			5	0.05								
13	699	Black Creek	95			5									
13	891	Middendorf	43	0.05	6	51	0.05								
13	984	Cape Fear	81		1	18									
14	255	Ellenton	81	0.05	1	18									
14	289	Ellenton	35	3	3	60	0.05								
14	299	Ellenton	86		4	10	0.05								
14	504	Black Creek	95			5									
14	527	Black Creek	89	0.05		10	1								
14	561	Black Creek	95			5	0.05								
14	655	Black Creek	49	1	1	48	0.05								
14	838	Middendorf	64	1		35									
15	21	Upland	90			10									
15	154	McBean	94		1	5									
15	199	Congaree	90		4	5									
15	265	Congaree	79		2	17	2								
15	347	Ellenton	89			10	1								
15	357	Ellenton	57	2		37	4								
15	411	Peedee	29			71	0.05								
15	451	Black Creek	94	1		5	0.05								

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
15	537	Black Creek	47	1		51									
15	671	Black Creek	17	0.05		83									
15	812	Middendorf	89			10	1								
15	878	Middendorf	95			5									
16	32	Dry Branch	98			2									
16	71	McBean	98			2									
16	134	Congaree	99						1						
16	233	Ellenton	95			5									
16	256	Ellenton	90	0.05		10	0.05								
16	263	Peedee	94	0.05		5									
16	389	Black Creek	90	0.05		10	0.05								
16	417	Black Creek	36	0.05		63	1								
16	553	Middendorf	69	0.05		30	0.05								
16	617	Middendorf	89	0.05		10	0.05								
16	638	Cape Fear	97	0.05		3									
17	45	Tobacco Road	90	0.05		10	0.05								
17	46	Tobacco Road	95			5									
17	135	Dry Branch	97	0.05		3									
17	182	McBean	88		2	10									
17	203	Congaree	98		2	0.05									
17	292	Williamsburg	100		0.05	0.05									
17	309	Ellenton	47		2	51									
17	310	Ellenton	38		1	61									
17	409	Peedee	82	0.05		18	0.05								
17	694	Black Creek	90	0.05		10									
18	85	Tobacco Road	95		5										
18	180	Congaree	73	0.05		24	3								
18	225	Congaree	99		1	0.05									

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
18	281	Williamsburg	100			0.05									
18	324	Ellenton	33	0.05	0.05	67									
18	395	Peedee	54			46	0.05								
18	477	Peedee	95	0.05		5									
18	557	Black Creek	89	0.05		10									
18	642	Black Creek	37	2		60				1					
18	832	Middendorf	95			5									
18	935	Cape Fear	82		8	9	0.05								
18	940	Cape Fear	58	0.05	2	38					2				
19	27	Upland	48	0.05	0.05	52									
19	175	McBean	89		0.05	10									
19	221	Congaree	97		0.05	3									
19	292	Williamsburg	44	1	1	51	2								
19	332	Williamsburg	82	0.05		18	0.05								
19	371	Ellenton	82	0.05		18									
19	406	Ellenton	51	0.05		49	0.05								
19	446	Peedee	90	0.05		10									
19	450	Peedee	53	1		46									
19	482	Peedee	90	0.05		10									
19	503	Peedee	60	1		39									
19	531	Peedee	82	1		18									
19	618	Black Creek	95			5									
19	653	Black Creek	95			5									
19	709	Black Creek	90			10									
19	742	Middendorf	82	0.05		18	0.05								
19	755	Middendorf	90			10						0.05			
19	772	Middendorf	95			5									
19	865	Middendorf	95			5									
19	879	Cape Fear	82	0.05	0.05	18	0.05								
19	916	Cape Fear	79		3	18									

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
20	21	Upland	60			40									
20	49	Tobacco Road	90			10									
20	109	Dry Branch	90			10									
20	145	Dry Branch	90			10									
20	223	Congaree	94		1	5									
20	246	Congaree	96		1	3									
20	307	Ellenton	45	0.05	0.05	54									
20	335	Ellenton	81	0.05	1	18									
20	369	Ellenton	94		0.05	5									
20	407	Peedeee	90	0.05	0.05	10									
20	439	Peedeee	90	0.05		10									
21	66	Tobacco Road	97		0.05	3									
21	173	McBean	26		0.05	42						7	26		
21	290	Congaree	97			2						1			
21	356	Williamsburg	90			10									
21	366	Ellenton	43		2	56									
21	476	Peedee	90			10									
21	490	Peedee	46			54									
21	526	Peedee	40			60									
21	814	Black Creek	86		4	10									
21	860	Middendorf	60			40									
21	982	Middendorf	95			5									
21	1074	Cape Fear	72		4	24									
21	1090	Cape Fear	79		3	18						0.05			
22	59	Tobacco Road	97			3									
22	65	Dry Branch	97		0.05	3									
22	132	Dry Branch	96		1	2				1					
22	253	Congaree	97			3									

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
22	333	Williamburg	57			43									
22	348	Williamburg	95			5									
22	355	Williamburg	90			10									
22	393	Ellenton	39		1	60									
22	453	Ellenton	90			10									
22	507	Peedee	97			3									
22	527	Peedee	90			10									
22	578	Peedee	95			5									
22	639	Black Creek	97			3									
22	735	Black Creek	70		7	23									
22	945	Middendorf	97			3									
22	943	Middendorf	97			3									
22	1005	Middendorf	95			5									
22	1028	Cape Fear	90			10									
23	33	Dry Branch	48		0.05	52									
23	39	Dry Branch	90			10									
23	77	Dry Branch	97			3									
23	103	McBean	39		1	21	2					37			
23	137	Congaree	99			0.05						1			
23	190	Williamsburg	18			73	8								
23	219	Williamsburg	90		0.05	10									
23	321	Peedee	35	0.05		65									
23	339	Peedee	90			10									
23	367	Peedee	46	0.05		54									
23	694	Black Creek	88			10	2								
23	818	Middendorf	95			5									
23	877	Cape Fear	95			5									
24	57	Upland	93		2	5									
24	70	Upland	33		4	64						0.05			

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
24	147	Dry Branch	90			10									
24	307	Congaree	95			5									
24	351	Willaimsburg	95			5									
24	419	Ellenton	38	0.05	2	57		3							
24	461	Ellenton	90			10									
24	469	Peedee	43	0.05		57									
24	490	Peedee	90			10									
24	500	Peedee	90		0.05	10									
24	527	Peedee	95			5									
24	563	Peedee	65			35									
24	592	Peedee	95			5									
24	663	Black Creek	59	1		39	1								
24	795	Black Creek	95	0.05		5									
24	965	Middendorf	95			5									
25	42	Tobacco Road	95			5									
25	50	Tobacco Road	90			10									
25	152	Dry Branch	90			10									
25	170	McBean	81			18		1							
25	177	Congaree	100			0.05									
25	302	Ellenton	95			5									
25	372	Peedee	32			68									
25	465	Peedee	82			18									
25	582	Black Creek	89			10	1								
25	742	Middendorf	82			18									
25	855	Middendorf	90			10									
26	50	Congaree	94		1	5									
26	129	Congaree	94		1	5									
26	173	Peedee	77		5	17		1							
26	247	Peedee	95			5									

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
26	309	Peedee	18			64								18	
26	527	Black Creek	89			10								1	
26	683	Middendorf	95			5									
27	59	Dry Branch	95		0.05	5									
27	134	McBean	95			5									
27	188	Congaree	94			5				1					
27	239	Williamsburg	21			48	14	8		1					8
27	486	Black Creek	94			5	1								
27	618	Middendorf	30			70									
27	685	Middendorf	82			18									
27	815	Middendorf	82			18									
28	95	Tobacco road	95			5									
28	125	Dry Branch	94		1	5									
28	145	McBean	70		2	23		5							
28	157	Congaree	89		1	10									
28	235	Ellenton	67		3	29	1								
28	333	Peedeee	90			10									
28	365	Peedeee	90			10									
28	445	Peedeee	94		1	5									
28	555	Black Creek	82		0.05	18									
28	565	Black Creek	90		0.05	10									
28	585	Black Creek	43			57	0.05								
28	670	Middendorf	73		2	24									
28	732	Middendorf	95			5									
28	755	Middendorf	90			10									
28	775	Middendorf	95		0.05	5									
29	91	Dry Branch	94			5									
29	187	Congaree	94			5									

Appendix II Table 1- X-ray diffraction analysis of selected sediment samples

P-well	depth	formation	quartz	plag	k-spar	clay	pyrite	gypsum	crist.	anhyd.	barite	calcite	clinopt	hema.	marc.
29	218	Ellenton	46			50	2								
29	348	Peedee	12			80	6								
29	428	Peedee	94			5									
29	478	Black Creek	94			5				1					
29	589	Middendorf	75			24									
29	677	Middendorf	94			5									
30	90	Tobacco Road	95			5									
30	105	Dry Branch	65		0.05	35									
30	147.5	Dry Branch	95			5									
30	152	Dry Branch	100			0.05									
30	227	Congaree	95			5									
30	272	Ellenton	95			5									
30	277	Ellenton	95			5									
30	342	Peedee	90			10									
30	407	Peedee	90		0.05	10									
30	427	Peedee	90			10									
30	527	Black Creek	60			40									
30	577	Black Creek	95			5									
30	625	Middendorf	70			30									
30	685	Middendorf	95			5									

plag = plagioclase feldspar
k-spar = potassium felspar
crist. = cristobalite [sic]
anhyd. = anhydrite
clinopt = clinoptilolite
hema. = hematite
marc. = marcasite

Appendix II. Table 2. XRF data on selected samples

		wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	ppm	ppm	wt%
WELL	DEPTH	SIO2	TIO2	AL2O3	FE2O3	MGO	MNO	CAO	K2O	NA2O	P2O5	S	CL	ZR	CR	SUM
13	44	61.9	0.69	23.12	3.4	0.14	0.06	0.40	0.50	0.09	0.02	0.04	< 0.02	564	32	90.4
13	44	61.8	0.69	23.18	3.4	0.14	0.05	0.39	0.50	0.09	0.03	0.04	< 0.02	565	32	90.4
13	33	41.2	1.41	36.12	8.3	0.19	0.04	0.16	1.09	0.10	0.03	0.03	< 0.02	540	80	88.7
13	33	41.4	1.40	36.30	8.3	0.19	0.04	0.16	1.09	0.10	0.03	0.03	< 0.02	535	82	89.1
13	218	79.7	0.32	6.80	4.4	0.99	0.10	2.96	0.47	0.32	1.85	0.04	< 0.02	447	25	98.0
13	254	98.6	0.17	2.39	0.6	0.23	0.01	0.23	0.13	0.09	0.02	0.15	< 0.02	530	42	102.6
13	327	51.1	1.11	19.79	7.7	2.04	0.07	1.22	1.98	0.09	0.06	0.91	< 0.02	249	138	86.1
13	390	62.7	0.76	12.04	9.2	0.97	0.03	0.84	1.34	0.09	0.16	1.28	< 0.02	179	216	89.5
13	422	44.1	1.27	39.49	1.4	0.05	0.01	0.35	0.61	0.09	0.11	0.07	< 0.02	428	120	87.5
13	434	102.8	0.22	2.13	0.2	0.02	0.00	0.13	0.01	0.06	0.01	0.13	< 0.02	318	16	105.7
13	636	101.1	0.05	1.83	0.3	0.07	0.02	0.69	0.08	0.07	0.01	0.13	< 0.02	74	16	104.3
13	699	44.0	1.43	22.80	8.4	2.37	0.09	0.73	3.04	0.11	0.08	0.96	< 0.02	450	99	84.1
13	699	43.9	1.44	22.73	8.4	2.40	0.09	0.74	3.04	0.11	0.08	0.96	< 0.02	455	100	84.0
13	891	75.2	1.48	15.97	1.3	0.05	0.02	0.16	0.18	0.07	0.05	0.04	< 0.02	1003	66	94.6
13	984	73.7	0.92	19.28	0.4	0.05	0.02	0.15	0.27	0.08	0.03	0.07	< 0.02	649	40	95.1
14	255	78.2	0.26	17.18	0.2	0.07	0.00	0.15	0.56	0.09	0.03	0.04	< 0.02	230	24	96.8
14	289	65.8	0.80	15.68	5.5	1.01	0.03	0.61	1.58	0.10	0.03	0.57	< 0.02	168	319	91.8
14	299	77.6	0.15	5.30	8.0	1.36	0.01	0.28	3.12	0.09	0.04	0.27	< 0.02	75	416	96.2
14	504	84.7	0.25	12.54	0.0	0.05	0.00	0.14	0.23	0.08	0.02	0.04	< 0.02	100	41	98.0
14	527	77.3	0.51	13.28	1.6	0.04	0.01	0.13	0.32	0.08	0.03	0.57	< 0.02	533	36	93.9
14	561	92.5	0.17	6.68	0.7	0.02	0.01	0.12	0.11	0.07	0.01	0.28	< 0.02	135	7	100.7
14	655	48.5	1.32	37.74	0.6	0.03	0.01	0.12	0.90	0.10	0.10	0.04	< 0.02	600	107	89.6
14	838	66.1	0.98	23.25	1.6	0.03	0.01	0.13	0.36	0.08	0.02	0.05	< 0.02	614	57	92.7
15	21	73.1	0.16	16.32	3.3	0.01	0.01	0.12	0.06	0.06	0.04	0.03	< 0.02	88	35	93.1
15	154	90.3	0.08	2.99	2.2	0.62	0.03	0.25	0.46	0.07	0.10	0.03	< 0.02	54	37	97.1
15	199	95.9	0.20	3.37	1.0	0.23	0.01	0.20	0.18	0.07	0.02	0.34	< 0.02	436	15	101.5
15	265	62.4	0.99	15.98	4.8	1.21	0.04	0.48	1.41	0.09	0.07	0.99	< 0.02	523	110	88.5
15	347	89.8	0.17	7.43	1.4	0.04	0.01	0.12	0.22	0.07	0.01	0.43	< 0.02	140	51	99.7
15	357	51.0	1.45	24.99	4.9	0.19	0.03	0.21	1.24	0.12	0.06	1.18	< 0.02	777	302	85.4

Appendix II. Table 2. XRF data on selected samples

WELL	DEPTH	wt% SIO2	wt% TIO2	wt% AL2O3	wt% FE2O3	wt% MGO	wt% MNO	wt% CAO	wt% K2O	wt% NA2O	wt% P2O5	wt% S	wt% CL	ppm ZR	ppm CR	wt% SUM
15	411	41.4	1.25	40.31	1.9	0.00	0.00	0.27	0.37	0.08	0.15	0.04	< 0.02	397	120	85.8
15	451	49.2	1.55	31.92	1.5	0.15	0.01	0.20	1.24	0.11	0.06	0.29	< 0.02	357	171	86.3
15	537	36.9	1.30	38.14	11.5	0.01	0.01	0.24	0.38	0.08	0.25	0.03	< 0.02	213	155	88.9
15	671	36.7	1.30	37.89	11.5	0.02	0.01	0.23	0.38	0.08	0.24	0.03	< 0.02	213	152	88.4
15	812	70.0	1.14	20.05	0.6	0.04	0.02	0.15	0.35	0.08	0.21	0.04	< 0.02	958	35	92.8
15	878	96.2	0.33	3.14	0.0	0.04	0.01	0.14	0.07	0.08	0.01	0.04	< 0.02	228	6	100.0
16	32	99.5	0.15	1.31	0.9	0.06	0.01	0.13	0.02	0.07	0.02	0.05	< 0.02	167	24	102.3
16	71	98.3	0.05	0.91	0.4	0.03	0.00	0.13	< 0.09	0.07	0.01	0.02	< 0.02	84	5	99.9
16	134	103.2	0.02	0.41	0.0	0.04	0.00	0.14	< 0.09	0.08	0.01	0.02	< 0.02	26	21	103.9
16	134	103.2	0.02	0.41	0.0	0.03	0.00	0.13	< 0.09	0.08	0.01	0.02	< 0.02	28	21	103.9
16	233	91.1	0.11	8.95	0.3	0.04	0.01	0.13	0.26	0.08	0.01	0.02	< 0.02	114	13	101.0
16	256	42.3	1.37	43.38	0.6	0.00	0.01	0.13	0.56	0.08	0.04	0.03	< 0.02	667	136	88.6
16	263	86.6	0.24	10.07	< 0.3	0.03	0.00	0.13	0.13	0.08	0.03	0.02	< 0.02	151	36	97.2
16	389	79.8	0.19	14.49	0.7	0.06	0.00	0.12	0.54	0.10	0.02	0.02	< 0.02	128	34	96.1
16	389	79.6	0.19	14.39	0.7	0.05	0.00	0.12	0.55	0.09	0.02	0.02	< 0.02	127	35	95.7
16	417	41.8	1.49	43.05	2.6	< 0.02	0.00	0.13	0.46	0.08	0.15	0.03	< 0.02	416	138	89.8
16	553	58.5	1.52	27.91	1.8	0.04	0.01	0.12	0.63	0.09	0.10	0.03	< 0.02	1202	69	90.9
16	617	73.6	0.47	19.61	0.0	0.05	0.01	0.12	0.72	0.09	0.03	0.02	< 0.02	251	20	94.8
16	638	98.6	0.32	3.64	< 0.3	0.04	0.01	0.12	0.08	0.08	0.01	0.02	< 0.02	447	3	102.8
17	45	73.5	0.40	16.93	2.1	0.06	0.03	0.13	0.21	0.08	0.03	0.03	< 0.02	488	18	93.6
17	46	82.3	0.22	13.26	1.4	0.05	0.02	0.12	0.13	0.07	0.02	0.02	< 0.02	225	9	97.6
17	135	99.6	0.08	1.65	0.1	0.13	0.03	0.14	0.04	0.08	0.04	0.02	< 0.02	89	25	101.9
17	182	86.4	0.45	5.38	2.2	0.67	0.02	0.94	0.83	0.09	0.07	0.43	< 0.02	494	24	97.5
17	203	101.4	0.04	0.81	1.1	0.07	0.01	0.35	0.10	0.08	0.27	0.03	< 0.02	67	11	104.3
17	292	102.1	0.08	1.25	0.1	0.09	0.01	0.15	0.10	0.07	0.03	0.02	< 0.02	100	18	104.0
17	309	49.4	1.46	22.08	10.7	1.97	0.02	0.94	2.68	0.12	0.20	0.03	< 0.02	380	184	89.7
17	310	42.7	1.23	18.97	10.9	1.64	0.06	0.94	2.25	0.08	0.05	2.54	< 0.02	300	161	81.4
17	409	57.3	0.80	30.05	0.7	0.07	0.01	0.20	0.66	0.09	0.07	0.09	< 0.02	290	76	90.1
17	694	84.6	0.17	12.55	0.1	0.03	0.01	0.13	0.36	0.09	0.01	0.12	< 0.02	133	14	98.2

Appendix II. Table 2. XRF data on selected samples

		wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	ppm	ppm	wt%
WELL	DEPTH	SIO2	TIO2	AL2O3	FE2O3	MGO	MNO	CAO	K2O	NA2O	P2O5	S	CL	ZR	CR	SUM
18	85	81.8	0.44	12.48	2.0	0.07	0.03	0.13	0.16	0.07	0.08	0.03	< 0.02	495	12	97.3
18	180	74.0	0.70	6.57	4.4	1.01	0.05	4.43	0.82	0.11	3.44	0.03	< 0.02	732	60	95.7
18	225	97.9	0.14	2.93	0.7	0.32	0.01	0.27	0.14	0.07	0.04	0.02	< 0.02	394	40	102.7
18	225	98.3	0.15	2.98	0.7	0.33	0.01	0.27	0.14	0.07	0.03	0.02	< 0.02	395	43	103.1
18	281	100.7	0.15	1.60	0.4	0.12	0.02	0.21	0.09	0.07	0.05	0.03	< 0.02	328	37	103.5
18	395	38.4	1.33	38.15	8.5	0.01	0.01	0.32	0.42	0.08	0.10	0.04	< 0.02	392	143	87.4
18	477	89.1	0.12	9.60	0.0	0.05	0.01	0.15	0.32	0.09	0.02	0.05	< 0.02	101	34	99.5
18	557	64.2	0.66	24.86	0.2	0.05	0.01	0.13	0.88	0.10	0.04	0.07	< 0.02	296	68	91.2
18	642	44.9	1.72	36.36	2.1	0.13	0.01	0.14	1.33	0.12	0.05	0.32	< 0.02	464	255	87.2
18	832	93.0	0.29	7.38	0.0	0.03	0.01	0.12	0.08	0.07	0.02	0.05	< 0.02	177	25	101.0
18	935	69.9	0.30	17.27	2.7	0.21	0.01	0.26	2.00	0.12	0.03	0.03	< 0.02	67	20	92.8
18	940	57.6	1.10	25.45	4.5	0.45	0.02	0.42	1.14	0.10	0.01	0.04	< 0.02	494	48	90.9
19	27	76.0	0.25	17.24	1.3	0.02	0.02	0.12	0.11	0.07	0.02	0.03	< 0.02	113	7	95.1
19	175	97.6	0.24	2.68	1.1	0.40	0.02	0.45	0.16	0.07	0.27	0.03	< 0.02	331	22	103.0
19	221	98.7	0.18	2.49	0.2	0.10	0.01	0.13	0.14	0.07	0.01	0.14	< 0.02	316	31	102.2
19	292	46.7	1.26	20.92	9.2	2.15	0.08	0.78	2.22	0.09	0.06	1.38	< 0.02	227	191	84.8
19	332	83.1	0.31	8.74	1.9	0.26	0.01	0.19	0.33	0.07	0.02	0.67	< 0.02	286	202	95.6
19	371	69.6	0.33	20.56	1.5	0.07	0.01	0.16	0.37	0.08	0.04	0.16	< 0.02	85	41	92.8
19	406	44.6	1.31	40.83	1.0	0.01	0.01	0.19	0.50	0.08	0.07	0.11	< 0.02	654	121	88.8
19	450	44.2	1.38	38.98	1.5	0.07	0.01	0.19	1.36	0.11	0.18	0.08	< 0.02	650	112	88.1
19	446	79.5	0.44	15.75	0.2	0.03	0.01	0.13	0.35	0.09	0.02	0.10	< 0.02	361	31	96.6
19	482	72.8	0.55	18.68	0.2	0.02	0.01	0.14	0.33	0.08	0.03	0.06	< 0.02	206	42	92.9
19	503	51.9	1.09	35.05	0.9	0.04	0.01	0.18	0.77	0.10	0.08	0.14	< 0.02	576	95	90.3
19	531	78.9	0.45	16.17	0.2	0.05	0.01	0.13	0.45	0.09	0.03	0.09	< 0.02	261	33	96.6
19	618	95.3	0.07	6.15	< 0.3	0.04	0.01	0.13	0.10	0.08	0.01	0.04	< 0.02	79	4	101.8
19	653	86.5	0.08	10.53	0.2	0.04	0.00	0.12	0.28	0.09	0.04	0.17	< 0.02	78	13	98.0
19	709	80.6	0.20	14.50	0.2	0.04	0.01	0.12	0.43	0.09	0.01	0.12	< 0.02	141	19	96.4
19	742	63.3	0.56	24.57	1.5	0.04	0.01	0.12	0.64	0.08	0.08	0.18	< 0.02	406	38	91.0
19	755	81.7	0.59	13.24	0.8	0.02	0.11	0.13	0.15	0.07	0.03	0.15	< 0.02	294	12	97.1

Appendix II. Table 2. XRF data on selected samples

WELL	DEPTH	wt% SIO2	wt% TIO2	wt% AL2O3	wt% FE2O3	wt% MGO	wt% MNO	wt% CAO	wt% K2O	wt% NA2O	wt% P2O5	wt% S	wt% CL	ppm ZR	ppm CR	wt% SUM
19	772	89.5	0.17	9.62	0.0	0.05	0.01	0.13	0.24	0.09	0.02	0.08	< 0.02	209	14	100.0
19	879	61.1	0.61	25.32	1.4	0.04	0.01	0.14	0.42	0.08	0.04	0.19	< 0.02	390	52	89.4
19	916	72.6	0.96	16.58	2.8	0.13	0.02	0.18	0.75	0.10	0.03	0.03	< 0.02	573	35	94.2
20	21	43.8	0.86	31.84	8.7	0.11	0.01	0.12	0.29	0.08	0.09	0.05	< 0.02	244	85	86.0
20	49	76.8	0.20	16.01	1.4	0.03	0.01	0.12	0.11	0.06	0.03	0.03	< 0.02	190	11	94.9
20	109	87.5	0.25	6.28	2.9	0.99	0.02	0.16	0.36	0.07	0.03	0.02	< 0.02	173	58	98.5
20	145	95.3	0.12	3.08	1.1	0.27	0.01	0.16	0.12	0.07	0.21	0.03	< 0.02	114	24	100.5
20	223	89.7	0.26	3.83	1.3	0.54	0.02	0.39	0.32	0.08	0.23	0.35	< 0.02	591	50	97.0
20	246	98.7	0.07	1.41	0.4	0.11	0.01	0.15	0.07	0.06	0.01	0.20	< 0.02	124	27	101.2
20	307	41.5	1.14	34.03	6.9	0.39	0.01	0.74	0.52	0.08	0.15	0.64	< 0.02	185	130	86.1
20	335	68.9	0.57	19.45	1.1	0.09	0.02	0.14	0.84	0.09	0.03	0.36	< 0.02	417	114	91.6
20	369	87.3	0.10	7.05	1.7	0.36	0.01	0.15	0.63	0.06	0.03	0.22	< 0.02	100	380	97.7
20	407	75.9	0.40	17.67	0.3	0.05	0.00	0.14	0.63	0.09	0.09	0.12	< 0.02	226	30	95.4
20	439	81.4	0.15	13.06	< 0.3	0.03	0.00	0.13	0.19	0.07	0.01	0.05	< 0.02	104	31	95.0
21	66	94.5	0.08	1.65	< 0.3	0.10	0.01	0.14	0.03	0.06	0.02	0.02	< 0.02	119	20	96.5
21	173	50.7	0.86	12.82	7.1	1.68	0.04	14.67	2.02	0.12	0.13	0.43	< 0.02	402	30	90.6
21	290	89.7	0.06	1.36	0.1	0.15	0.01	0.70	0.10	0.09	0.02	0.09	< 0.02	75	5	92.4
21	356	81.7	0.53	12.37	0.1	0.08	0.01	0.23	0.38	0.08	0.03	0.06	< 0.02	509	32	95.7
21	366	50.8	1.50	23.32	6.8	1.23	0.04	0.97	2.23	0.11	0.06	0.80	< 0.02	329	444	88.0
21	476	73.7	0.44	17.12	0.6	0.07	0.01	0.17	0.62	0.09	0.10	0.18	< 0.02	298	20	93.1
21	490	41.2	1.24	32.54	10.2	0.07	0.01	0.28	0.82	0.10	0.07	0.04	< 0.02	313	125	86.6
21	526	43.4	1.40	36.86	6.8	0.05	0.01	0.31	0.64	0.09	0.07	0.05	< 0.02	363	133	89.7
21	814	85.0	0.89	7.48	3.0	0.14	0.36	0.25	0.85	0.10	0.02	0.29	< 0.02	242	30	98.4
21	860	50.3	1.54	31.83	4.3	0.14	0.02	0.29	0.94	0.11	0.08	0.05	< 0.02	680	94	89.6
21	982	88.7	0.07	2.10	< 0.3	0.03	0.00	0.13	0.03	0.07	0.01	0.03	< 0.02	41	- 1	91.0
21	1074	64.7	0.61	17.34	6.7	0.23	0.02	0.27	1.66	0.14	0.03	0.04	< 0.02	220	40	91.8
21	1090	77.6	0.24	12.49	2.9	0.22	0.01	0.26	1.19	0.14	0.01	0.03	< 0.02	59	23	95.1
22	59	90.2	0.16	4.99	1.7	0.53	0.03	0.19	0.27	0.08	0.24	0.03	< 0.02	57	25	98.4

Appendix II. Table 2. XRF data on selected samples

		wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	ppm	ppm	wt%
WELL	DEPTH	SIO2	TIO2	AL2O3	FE2O3	MGO	MNO	CAO	K2O	NA2O	P2O5	S	CL	ZR	CR	SUM
22	65	88.7	0.20	5.13	1.7	0.60	0.10	0.33	0.26	0.07	0.13	0.04	< 0.02	313	27	97.3
22	132	91.0	0.38	4.49	1.8	0.47	0.05	0.35	0.45	0.09	0.55	0.03	< 0.02	597	38	99.7
22	253	99.8	0.09	1.68	0.4	0.31	0.01	0.96	0.09	0.08	0.77	0.03	< 0.02	350	21	104.2
22	333	50.5	1.27	35.63	1.4	0.15	0.00	0.30	1.00	0.10	0.04	0.06	< 0.02	741	105	90.5
22	348	84.6	0.29	11.45	0.1	0.07	0.01	0.15	0.38	0.09	0.04	0.05	< 0.02	231	26	97.2
22	355	80.4	0.35	15.01	0.0	0.10	0.01	0.14	0.53	0.09	0.02	0.05	< 0.02	317	27	96.7
22	393	72.6	0.72	11.58	4.8	0.97	0.03	1.67	1.29	0.10	0.61	0.39	< 0.02	253	197	94.8
22	453	82.8	0.26	13.76	0.4	0.04	0.06	0.14	0.37	0.08	0.02	0.06	< 0.02	191	14	98.0
22	507	91.5	0.16	8.03	< 0.3	0.04	0.01	0.13	0.18	0.07	0.02	0.05	< 0.02	151	17	100.1
22	527	82.5	0.21	14.72	< 0.3	0.06	0.01	0.14	0.41	0.09	0.02	0.04	< 0.02	171	14	98.1
22	578	83.5	0.19	11.23	0.4	0.03	0.02	0.13	0.28	0.08	0.02	0.19	< 0.02	161	36	96.1
22	639	96.0	0.05	3.94	0.5	0.04	0.01	0.14	0.07	0.07	0.01	0.28	< 0.02	67	8	101.0
22	735	60.0	0.78	14.36	8.5	1.13	0.35	0.55	2.60	0.12	0.20	0.52	< 0.02	368	72	89.1
22	945	95.7	0.72	4.08	0.1	0.05	0.02	0.13	0.10	0.07	0.03	0.04	< 0.02	591	35	101.1
22	943	97.4	0.15	4.32	< 0.3	0.04	0.01	0.14	0.09	0.07	0.01	0.04	< 0.02	117	3	102.2
22	1005	89.0	0.12	8.48	0.2	0.04	0.00	0.13	0.12	0.07	0.02	0.13	< 0.02	86	3	98.3
22	1028	68.0	0.38	23.45	0.5	0.06	0.01	0.14	0.85	0.10	0.03	0.04	< 0.02	165	30	93.5
23	39	79.7	0.40	10.74	2.6	0.13	0.02	0.13	0.14	0.08	0.12	0.03	< 0.02	280	55	94.2
23	77	95.9	0.15	3.57	1.0	0.43	0.66	0.32	0.18	0.08	0.06	0.04	< 0.02	74	13	102.4
23	33	51.3	1.59	22.72	9.3	1.70	0.03	0.20	1.42	0.09	0.44	0.03	< 0.02	963	175	88.9
23	103	32.0	0.25	4.66	6.6	1.06	0.02	40.54	0.57	0.10	0.23	0.49	< 0.02	164	-24	86.6
23	137	100.8	0.06	0.73	< 0.3	0.05	0.01	0.19	0.02	0.07	0.01	0.08	< 0.02	250	22	101.9
23	190	34.3	1.35	38.17	10.2	< 0.02	0.01	0.24	0.05	0.03	0.03	1.93	< 0.02	172	137	86.2
23	219	87.3	0.10	10.40	0.3	0.03	0.01	0.13	0.39	0.08	0.02	0.17	< 0.02	88	9	98.9
23	321	39.0	1.22	35.06	10.7	0.09	0.01	0.32	0.83	0.10	0.11	0.05	< 0.02	321	115	87.5
23	339	75.9	0.32	18.22	0.4	0.02	0.01	0.14	0.34	0.08	0.04	0.14	< 0.02	214	30	95.6
23	367	44.6	1.36	38.63	3.2	0.07	0.01	0.26	0.93	0.10	0.04	0.06	< 0.02	612	121	89.4
23	694	79.0	0.39	15.89	0.1	0.04	0.01	0.14	0.43	0.10	0.03	0.05	< 0.02	237	16	96.2
23	818	89.9	0.23	10.08	< 0.3	0.02	0.01	0.12	0.20	0.07	0.02	0.04	< 0.02	144	15	100.6
23	877	71.4	0.68	19.57	1.2	0.06	0.01	0.16	0.21	0.09	0.02	0.04	< 0.02	270	52	93.4

Appendix II. Table 2. XRF data on selected samples

WELL	DEPTH	wt% SIO2	wt% TIO2	wt% AL2O3	wt% FE2O3	wt% MGO	wt% MNO	wt% CAO	wt% K2O	wt% NA2O	wt% P2O5	wt% S	wt% CL	ppm ZR	ppm CR	wt% SUM
24	57	83.9	0.10	12.27	0.3	0.04	0.01	0.12	1.68	0.11	0.01	0.03	< 0.02	49	16	98.6
24	70	44.6	1.53	29.22	8.0	1.21	0.04	0.51	2.31	0.10	0.04	0.05	< 0.02	416	115	87.6
24	147	91.4	0.21	4.19	1.7	0.68	0.07	0.27	0.28	0.07	0.20	0.04	< 0.02	257	29	99.1
24	307	97.2	0.19	3.40	0.7	0.23	0.02	0.18	0.20	0.08	0.04	0.03	< 0.02	233	38	102.3
24	351	83.7	0.65	8.05	0.5	0.05	0.03	0.14	0.20	0.08	0.06	0.03	< 0.02	916	23	93.6
24	419	69.2	0.73	13.99	4.8	0.81	0.02	0.71	1.38	0.10	0.20	0.41	< 0.02	143	268	92.4
24	461	86.3	0.30	8.51	0.8	0.04	0.01	0.16	0.13	0.07	0.04	0.28	< 0.02	285	27	96.7
24	469	43.5	1.19	39.92	3.6	0.05	0.01	0.26	0.67	0.09	0.05	0.05	< 0.02	340	119	89.4
24	490	70.5	0.38	19.90	0.5	0.07	0.01	0.15	0.69	0.11	0.07	0.06	< 0.02	203	52	92.4
24	500	88.8	0.28	10.03	0.0	0.08	0.01	0.18	0.34	0.10	0.02	0.03	< 0.02	258	12	99.9
24	527	94.2	0.17	7.36	< 0.3	0.06	0.01	0.15	0.18	0.08	0.01	0.05	< 0.02	159	14	102.2
24	563	51.4	1.44	35.73	0.6	0.01	0.00	0.21	0.34	0.08	0.08	0.15	< 0.02	933	94	90.1
24	592	92.3	0.12	6.46	< 0.3	0.05	0.01	0.14	0.27	0.08	0.01	0.03	< 0.02	89	43	99.3
24	663	47.1	1.14	24.83	5.4	0.05	0.02	0.21	1.48	0.09	0.04	1.80	< 0.02	429	125	82.1
24	795	78.9	0.16	15.37	< 0.3	0.04	0.01	0.12	0.40	0.08	0.01	0.05	< 0.02	97	26	95.0
24	965	90.6	0.33	7.24	< 0.3	0.03	0.01	0.13	0.02	0.07	0.02	0.03	< 0.02	195	29	98.3
25	42	89.9	0.06	8.21	0.3	0.03	0.01	0.14	0.00	0.07	0.04	0.02	< 0.02	95	13	98.7
25	50	87.2	0.32	9.72	1.2	0.10	0.04	0.14	0.07	0.07	0.18	0.03	< 0.02	450	18	99.0
25	152	82.7	0.15	5.72	4.0	1.22	0.01	0.52	0.67	0.07	0.02	0.04	< 0.02	63	114	95.2
25	170	77.2	0.44	6.51	3.5	1.01	0.02	0.52	0.51	0.06	0.03	1.05	< 0.02	707	67	91.0
25	177	101.5	0.05	1.37	0.7	0.14	0.01	0.19	0.05	0.07	0.07	0.03	< 0.02	88	15	104.2
25	302	83.4	0.14	10.85	0.8	0.05	0.01	0.16	0.22	0.08	0.02	0.33	< 0.02	131	30	96.0
25	372	39.9	1.31	40.06	6.4	0.05	0.01	0.26	0.66	0.08	0.08	0.03	< 0.02	178	129	88.8
25	465	81.1	0.24	14.87	0.0	0.06	0.01	0.15	0.48	0.10	0.02	0.04	< 0.02	131	19	97.1
25	582	88.4	0.14	6.84	0.8	0.05	0.03	0.14	0.14	0.09	0.01	0.29	< 0.02	95	4	96.9
25	742	67.0	0.90	22.27	1.5	0.07	0.01	0.16	0.42	0.09	0.09	0.06	< 0.02	659	50	92.6
25	855	87.2	0.31	10.73	< 0.3	0.05	0.01	0.14	0.19	0.08	0.02	0.03	< 0.02	193	18	98.7
26	50	97.0	0.07	1.58	0.7	0.21	0.01	0.16	0.29	0.09	0.05	0.03	< 0.02	67	20	100.2

Appendix II. Table 2. XRF data on selected samples

WELL	DEPTH	wt% SIO2	wt% TIO2	wt% AL2O3	wt% FE2O3	wt% MGO	wt% MNO	wt% CAO	wt% K2O	wt% NA2O	wt% P2O5	wt% S	wt% CL	ppm ZR	ppm CR	wt% SUM
26	129	101.5	0.12	1.50	0.1	0.11	0.01	0.13	0.09	0.07	0.01	0.08	< 0.02	179	12	103.7
26	173	78.0	0.42	10.07	3.0	0.69	0.01	0.35	1.56	0.09	0.03	0.43	< 0.02	288	125	94.7
26	247	86.0	0.13	10.47	< 0.3	0.05	0.00	0.13	0.29	0.08	0.01	0.05	< 0.02	88	18	97.1
26	309	32.8	1.58	40.04	13.7	0.02	0.01	0.24	0.71	0.10	0.12	0.03	< 0.02	249	211	89.4
26	527	97.8	0.06	4.41	< 0.3	0.04	0.00	0.12	0.12	0.07	0.01	0.04	< 0.02	68	4	102.5
26	683	87.4	0.25	9.10	0.1	0.06	0.01	0.12	0.36	0.08	0.01	0.08	< 0.02	157	26	97.6
27	59	92.1	0.27	3.50	1.1	0.50	0.12	0.98	0.17	0.09	1.44	0.03	< 0.02	448	17	100.3
27	134	93.4	0.12	2.23	1.4	0.16	0.01	0.18	0.12	0.08	0.14	0.03	< 0.02	152	21	97.8
27	188	99.5	0.07	1.34	0.1	0.09	0.01	0.14	0.06	0.06	0.03	0.03	< 0.02	101	5	101.5
27	239	29.8	0.88	24.81	18.1	0.18	0.04	0.70	0.14	< 0.01	0.02	4.36	< 0.02	78	111	79.0
27	486	89.3	0.12	8.83	< 0.3	0.05	0.00	0.13	0.29	0.08	0.01	0.04	< 0.02	90	9	98.8
27	618	41.3	1.44	43.47	1.1	0.03	0.01	0.12	1.02	0.09	0.05	0.04	< 0.02	432	93	88.6
27	685	69.6	0.41	19.70	0.4	0.09	0.01	0.12	1.17	0.12	0.01	0.13	< 0.02	179	33	91.8
27	815	73.2	0.75	18.18	0.3	0.03	0.01	0.12	0.27	0.08	0.04	0.10	< 0.02	420	31	93.2
28	95	86.7	0.26	7.41	2.0	0.12	0.01	0.12	0.15	0.07	0.14	0.03	< 0.02	205	12	97.0
28	125	96.4	0.24	2.05	0.7	0.25	0.03	0.35	0.29	0.08	0.15	0.03	< 0.02	265	20	100.6
28	145	75.4	0.78	7.60	3.9	0.94	0.04	0.61	0.95	0.08	0.09	0.70	< 0.02	900	53	91.3
28	157	93.7	0.26	3.51	1.6	0.38	0.02	0.36	0.23	0.08	0.19	0.04	< 0.02	685	44	100.4
28	235	56.0	0.93	25.06	2.0	0.12	0.02	0.17	2.07	0.12	0.03	0.71	< 0.02	526	119	87.3
28	333	86.4	0.20	11.36	0.0	0.06	0.00	0.13	0.39	0.09	0.02	0.09	< 0.02	130	12	98.8
28	365	84.2	0.18	11.72	0.2	0.03	0.00	0.15	0.32	0.09	0.02	0.15	< 0.02	126	32	97.0
28	445	87.1	1.24	9.51	0.4	0.05	0.03	0.13	0.26	0.09	0.05	0.09	< 0.02	763	22	99.1
28	555	64.4	0.80	24.44	0.6	0.05	0.01	0.12	0.77	0.10	0.04	0.13	< 0.02	566	60	91.6
28	565	83.0	0.51	12.61	0.3	0.05	0.01	0.12	0.38	0.09	0.03	0.15	< 0.02	631	26	97.3
28	585	45.4	1.32	38.35	2.3	0.03	0.01	0.12	0.78	0.10	0.07	0.20	< 0.02	458	112	88.7
28	670	60.8	1.61	25.40	1.9	0.00	0.01	0.12	0.13	0.08	0.08	0.13	< 0.02	787	72	90.4
28	732	92.0	0.26	6.16	0.1	0.04	0.01	0.12	0.11	0.08	0.01	0.03	< 0.02	137	8	98.9
28	755	79.8	0.21	15.40	< 0.3	0.02	0.00	0.12	0.34	0.08	0.02	0.04	< 0.02	122	17	95.9
29	218	45.7	1.24	26.93	6.4	0.14	0.03	0.13	1.12	0.09	0.07	1.76	< 0.02	497	195	83.7

Appendix II. Table 2. XRF data on selected samples

		wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	ppm	ppm	wt%
WELL	DEPTH	SIO2	TIO2	AL2O3	FE2O3	MGO	MNO	CAO	K2O	NA2O	P2O5	S	CL	ZR	CR	SUM
29	348	31.5	1.32	36.79	8.0	< 0.02	0.02	0.11	0.76	0.06	0.04	1.78	< 0.02	344	135	80.4
29	428	83.2	0.13	12.49	< 0.3	0.04	0.00	0.12	0.36	0.09	0.03	0.03	< 0.02	83	32	96.4
29	478	84.9	0.28	10.79	0.6	0.04	0.01	0.12	0.27	0.09	0.02	0.03	< 0.02	232	14	97.1
29	589	56.7	1.37	28.66	1.7	0.00	0.01	0.12	0.26	0.08	0.04	0.06	< 0.02	794	90	89.1
29	677	81.6	0.53	12.67	0.2	0.02	0.01	0.12	0.11	0.06	0.02	0.02	< 0.02	206	40	95.3
30	90	98.0	0.16	3.17	0.7	0.03	0.01	0.12	0.02	0.06	0.14	0.02	< 0.02	223	11	102.4
30	105	58.9	0.74	12.08	10.3	1.47	0.03	0.16	1.01	0.11	3.46	0.03	< 0.02	395	98	88.3
30	227	101.4	0.09	1.21	0.2	0.03	0.00	0.12	0.01	0.08	0.01	0.02	< 0.02	148	4	103.2
30	272	96.5	0.24	4.04	0.1	0.05	0.01	0.13	0.11	0.08	0.02	0.02	< 0.02	248	8	101.2
30	277	93.6	0.20	5.84	< 0.3	0.05	0.01	0.13	0.13	0.09	0.01	0.02	< 0.02	148	19	100.0
30	342	73.7	0.33	19.22	0.2	0.06	0.00	0.12	0.79	0.11	0.03	0.02	< 0.02	171	34	94.5
30	407	79.7	0.26	15.18	< 0.3	0.03	0.00	0.12	0.42	0.09	0.02	0.02	< 0.02	131	28	95.8
30	427	90.6	0.09	7.53	< 0.3	0.02	0.00	0.12	0.17	0.07	0.01	0.02	< 0.02	79	32	98.4
30	527	40.4	1.40	40.32	5.1	0.01	0.01	0.12	0.62	0.08	0.05	0.03	< 0.02	369	105	88.1
30	577	80.4	0.13	14.17	0.0	0.05	0.00	0.12	0.37	0.09	0.02	0.02	< 0.02	101	19	95.3
30	625	51.4	1.41	32.17	2.1	0.02	0.01	0.12	0.26	0.07	0.07	0.03	< 0.02	524	77	87.7

Appendix II. table 3. Clay minera~~l~~ analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
13	33	Upland	59	Major	Trace		
13	44	Upland	30	Major	Trace		
13	218	McBean	23			Major	
13	254	Congaree	5	Minor	Minor	Major	
13	327	Congaree	64	Major	Minor	Minor	
13	390	Ellenton	58	Minor	Minor	Minor	
13	422	Ellenton	61	Minor	Minor	Minor	
13	434	Peedee	64	Major		Trace	
13	636	Black Creek	5	Major		Minor	
13	699	Black Creek	5		Major		
13	891	Middendorf	51	Major	Trace		
13	984	Cape Fear	18	Major	Trace		
14	255	Ellenton	18	Major	Minor		
14	289	Ellenton	60	Major	Minor	Minor	
14	299	Ellenton	10	Minor	Major		
14	504	Black Creek	5	Major	Trace		
14	527	Black Creek	10	Major	Trace		
14	561	Black Creek	5	Major			
14	655	Black Creek	48	Major	Trace		trace chlorite
14	838	Middendorf	35	Major	Trace		
15	21	Upland	10	Major			
15	154	McBean	5	Trace	Minor	Major	
15	199	Congaree	5	Major	Minor	Minor	
15	265	Congaree	17	Major	Minor	Minor	
15	347	Ellenton	10	Major	Minor	Trace	
15	357	Ellenton	37	Major	Minor		
15	411	Peedee	71	Major	Minor		
15	451	Black Creek	5	Major		Trace	
15	537	Black Creek	51	Major	Minor		
15	671	Black Creek	83	Major	Trace		
15	812	Middendorf	10	Major	Minor	Trace	
15	878	Middendorf	5	Major			trace vermiculit
16	32	Dry Branch	2	Major		Minor	
16	71	McBean	2	Minor		Major	
16	134	Congaree	0	Trace		Major	
16	233	Ellenton	5	Major		Minor	
16	256	Ellenton	10	?	?	?	?
16	263	Peedee	5	Major		Minor	
16	389	Black Creek	10	Major	Trace	minor	
16	417	Black Creek	63	Major			
16	553	Middendorf	30	Major	Trace		

Appendix II. table 3. Clay mineral analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
16	617	Middendorf	10	Major	Trace		
16	638	Cape Fear	3	Minor	Minor	Major	
17	45	Tobacco Road	10	Major			
17	46	Tobacco Road	5	Major	Trace	Trace	
17	135	Dry Branch	3		Trace	Major	
17	203	Congaree	0.05	Trace	Trace	Major	
17	292	Williamsburg	0.05	Minor	Minor	Major	
17	309	Ellenton	51	Minor	Minor	Minor	
17	310	Ellenton	61	Minor	Minor	Minor	
17	409	Peedee	18	Major	Trace		
17	694	Black Creek	10	Major	Trace		
18	85	Tobacco Road	0	Major	Trace		
18	180	Congaree	24	Minor	Minor	Major	
18	225	Congaree	0.05	Minor	Trace	Major	
18	281	Williamsburg	0.05	Minor	Trace	Minor	
18	395	Peedee	46	Major			
18	477	Peedee	5	Major	Minor	Minor	
18	557	Black Creek	10	Major	Minor		
18	642	Black Creek	60	Major	Minor		
18	832	Middendorf	5	Major	Minor	Trace	
18	935	Cape Fear	9	Major	Minor	Minor	
18	940	Cape Fear	38	Major	Trace	Minor	
19	27	Upland	52	Major			
19	175	McBean	10	Minor	Minor	Major	
19	292	Williamsburg	51	Major	Minor	Minor	
19	332	Williamsburg	18	Major	Trace		
19	371	Ellenton	18	Major	Trace		
19	406	Ellenton	49	Major	Trace		
19	446	Peedee	10	Major	Trace		
19	450	Peedee	46	Major	Trace		
19	482	Peedee	10	Major			
19	503	Peedee	39	Major	Trace		
19	531	Peedee	18	Major	Trace		
19	618	Black Creek	5	Major	Trace	Trace	
19	653	Black Creek	5	Major	Trace	Trace	
19	709	Black Creek	10	Major	Trace		
19	742	Middendorf	18	Major	Trace		
19	755	Middendorf	10	Major	Trace		
19	772	Middendorf	5	Major			
19	865	Middendorf	5	Major			
19	879	Cape Fear	18	Major	Trace	Trace	
19	916	Cape Fear	18	Major	Trace	Trace	

Appendix II. table 3. Clay mineral analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
20	21	Upland	40	Major	Trace		Chlorite (?)
20	49	Tobacco Road	10	Major			
20	109	Dry Branch	10	Minor	Minor	Major	
20	145	Dry Branch	10	Minor	Minor	Major	
20	223	Congaree	5	Minor	Minor	Major	
20	307	Ellenton	54	Major	Trace	Minor	
20	335	Ellenton	18	Major	Trace		
20	369	Ellenton	5	Major	Trace		
20	407	Peedeee	10	Major	Trace		
20	439	Peedeee	10	Major	Trace		
21	66	Tobacco Road	3	Trace	Trace	Major	
21	173	McBean	42	Trace	Minor	Major	Clinoptilolite
21	290	Congaree	2	Minor	Minor	Major	Clinoptilolite
21	356	Williamsburg	10	Major	Trace	Trace	
21	366	Ellenton	56	Major	Minor	Minor	
21	476	Peedee	10	Major	Trace		
21	490	Peedee	54	Major	Trace		
21	526	Peedee	60	Major	Trace		
21	814	Black Creek	10	Major	Trace	Trace	
21	860	Middendorf	40	Major	Trace		
21	982	Middendorf	5	Major		Minor	
21	1074	Cape Fear	24	Major		Trace	
21	1090	Cape Fear	18	Major	Trace	Minor	
22	59	Tobacco Road	3	Trace	Major	Major	
22	65	Dry Branch	3	Trace	Trace	Major	
22	132	Dry Branch	2	Trace	Minor	Major	
22	253	Congaree	3	Trace	Trace	Major	
22	333	Williamburg	43	Major	Minor		
22	348	Williamburg	5	Major	Trace	Trace	
22	355	Williamburg	10	Major	Minor	Minor	
22	393	Ellenton	60	Minor	Minor	Minor	
22	453	Ellenton	10	Major	Trace		
22	507	Peedee	3	Major			
22	527	Peedee	10	Major		Trace	
22	578	Peedee	5	Major	Minor		
22	639	Black Creek	3	Major	Minor	Trace	
22	735	Black Creek	23	Minor	Major	Trace	
22	945	Middendorf	3	Major	Minor	Trace	
22	943	Middendorf	3	Major	Minor		
22	1005	Middendorf	5	Major	Minor	Trace	
22	1028	Cape Fear	10	Major	Trace		

Appendix II. table 3. Clay minera~~l~~ analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
23	33	Dry Branch	52	Major	Minor	Minor	
23	39	Dry Branch	10	Major	Trace		trace Chlorite
23	77	Dry Branch	3	Minor	Minor	Major	
23	103	McBean	21	Trace	Trace	Minor	Calcite
23	137	Congaree	0.05	Minor	Minor	Major	
23	190	Williamsburg	73	Major			
23	219	Williamsburg	10	Major	Minor		
23	321	Peedee	65	Major	Minor		
23	339	Peedee	10	Major	Trace		
23	367	Peedee	54	Major	Trace		
23	694	Black Creek	10	Major	Minor		
23	818	Middendorf	5	Major	Trace		
23	877	Cape Fear	5	Major			
24	57	Upland	5	Major	Trace		
24	70	Upland	64	Major	Trace	Major	
24	147	Dry Branch	10	Trace	Minor	Major	
24	307	Congaree	5	Major	Minor	Major	
24	419	Ellenton	57	Major		Minor	
24	461	Ellenton	10	Major	Trace		
24	469	Peedee	57	Major	Minor		
24	490	Peedee	10	Major	Minor		
24	500	Peedee	10	Major	Minor	Minor	
24	527	Peedee	5	Major	Trace	Trace	
24	563	Peedee	35	Major	Trace		
24	592	Peedee	5	Major	Minor	Trace	
24	663	Black Creek	39	Major	Trace		
24	795	Black Creek	5	Major	Trace	Trace	
24	965	Middendorf	5	Major			
25	42	Tobacco Road	5	Major		Trace	
25	50	Tobacco Road	10	Major	Minor	Trace	
25	152	Dry Branch	10	Minor	Trace	Major	
25	170	McBean	18	Minor	Trace	Major	
25	177	Congaree	0.05	Minor	Trace	Major	
25	302	Ellenton	5	Major	Trace		
25	372	Peedee	68	Major	Trace		
25	465	Peedee	18	Major	Trace	Trace	
25	582	Black Creek	10	Major	Trace	Trace	
25	742	Middendorf	18	Major	Trace		
25	855	Middendorf	10	Major			
26	50	Congaree	5	Minor		Major	
26	129	Congaree	5	Major	Minor	Minor	
26	173	Peedee	17	Major	Major		

Appendix II. table 3. Clay mineral analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
26	247	Peedee	5	Major	Trace	Trace	
26	309	Peedee	64	Major	Trace		
26	527	Black Creek	10	Major	Trace	Trace	
26	683	Middendorf	5	Major	Minor	Trace	
27	59	Dry Branch	5	Minor	Minor	Major	
27	134	McBean	5	Minor	Minor	Major	
27	188	Congaree	5	Major	Minor	Major	
27	239	Williamsburg	48	Major		Minor	
27	486	Black Creek	5	Major	Trace	Trace	
27	618	Middendorf	70	Major	Minor		
27	685	Middendorf	18	Major	Minor		
27	815	Middendorf	18	Major	Minor		
28	95	Tobacco road	5	Major	Minor		
28	125	Dry Branch	5	Minor	Minor	Major	
28	145	McBean	23	Major	Minor	Major	
28	157	Congaree	10	Major	Trace	Major	
28	235	Ellenton	29	Major	Minor		
28	333	Peedeee	10	Major	Trace		
28	365	Peedeee	10	Major	Trace		
28	445	Peedeee	5	Major	Trace		
28	555	Black Creek	18	Major	Minor		
28	565	Black Creek	10	Major			
28	585	Black Creek	57	Major	Minor		
28	670	Middendorf	24	Major	Minor		
28	732	Middendorf	5	Major		Trace (?)	
28	755	Middendorf	10	Major	Trace		
28	775	Middendorf	5	Major	Trace	Minor	
29	91	Dry Branch	5	Major	Minor	Minor	
29	187	Congaree	5	Major	Trace	Major	
29	218	Ellenton	50	Major	Trace		
29	348	Peedee	80	Major	Minor		
29	428	Peedee	5	Major	Trace	Trace	
29	478	Black Creek	5	Major	Trace	Minor	
29	589	Middendorf	24	Major	Trace		
29	677	Middendorf	5	Major	Trace		
30	90	Tobacco Road	5	Major	Trace	Minor	
30	105	Dry Branch	35	Minor	Minor	Major	I/V mixed Layer
30	148	Dry Branch	5	Major	Minor	Trace	
30	152	Dry Branch	0.05	Major	Trace	Major	
30	227	Congaree	5	Minor	Trace	Major	
30	272	Ellenton	5	Minor	Trace	Major	

Appendix II. table 3. Clay mineral analysis of selected samples

Well No.	Depth (ft)	Formation	% Clay (1)	Kaolinite	Illite	Smectite	Other/comment
30	277	Ellenton	5	Minor	Trace	Major	
30	342	Peedee	10	Major	Minor		
30	407	Peedee	10	Major			
30	427	Peedee	10	Major	Trace	Minor	
30	527	Black Creek	40	Major	Minor		
30	577	Black Creek	5	Major	Trace	Minor	
30	625	Middendorf	30	Major	Trace		
30	685	Middendorf	5	Major	Trace		

(1) based on XRD of whole rock sample (Appendix II, table 1)

appendix III Table 1. Field and major ion data

Well No.		P13A	P13TD	P13TC	P13TA	IDB-IC	P14C	P14TC	P14TB
Screened elevation	38	-63	-182	-382	-667	203	143	-202	-267
Unit	IIB	IIA	IB	IB	IA	WT	IIB	IB	IB
Sample date	12/31/88	12/31/88	11/16/88	11/16/88	11/16/88	12/30/88	12/30/88	12/30/88	12/30/88
Temp. (oC)	20.1	20.1	20.9	22	23.1	18.5	19	20.7	20.4
pH units	6	6.9	6.6	6.1	5.8	5.2	7.7	5.1	5.8
Sp. Cond (uS)	68	183	123	76	60	22	156	44	56
TDS (mg/L)	45	116	70	45	35	15.5	102.5	32.5	38
ORP (V)	0.12	-0.025	-0.147	0.012	0.006	0.298	0.048	0.065	-0.004
Eh (mV)	319	174	52	211	205	497	247	264	195
DO (mg/L)	7.79	0.06	0.02	0.06	0.01	9.6	6.62	0.04	0.02
Cations									
Ca 2+ (mg/l)	9.50	36.00	11.00	7.60	3.00	1.20	33.00	3.60	3.20
Mg 2+ (mg/l)	0.79	1.1	0.58	0.9	0.42	0.4	0.62	0.31	0.38
Na+ (mg/l)	2	1.8	5.3	0.93	2	1.1	1.4	0.99	1.8
K+ (mg/l)	1.4	1.7	7.2	3.3	3.3	0.3	0.75	1.3	2.1
Anions									
HCO3- (mg/l)	27.8	89.4	48.3	22.9	9.7	1.2	85.7	2.4	8.5
CO3 2- (mg/l)									
SO4 2- (mg/l)	2.2	12.2	11.4	9.35	11.8	0.36	3.8	10.1	10.3
Cl- (mg/l)	2.3	2.5	1.91	1.8	1.55	1.5	2.3	1.7	1.7
F- (mg/l)	0.14	0.11	0.199	0.064	0.065	<0.047	0.055	<0.047	<0.047
NO3 2- (mg/l)									
Ion Balance	7.1	5.6	-3.9	-3.8	-11.9	36.4	6.8	-2.9	-10.9

appendix III Table 1. Field and major ion data

Well No.	P14TA	P15A	P15TC	P15TB	P15TA	P16B	P16A	P16TC	P16TB
Screened elevation	-536	-92	-362	-462	-628	186	126	-125	-189
Unit	IA	IIA	CIA-IB	IA	IA	I/IIC	I/IIC	I/IIB	I/IIA
Sample date	12/30/88	11/19/88	11/19/88	11/17/88	11/19/88	2/4/89	2/4/89	2/4/89	2/4/89
Temp. (oC)	21.8	20.5	21.8	22.2	22.9	18.2	18.6	20	20.3
pH units	5.1	6.3	5.9	5.9	6.1	5	4.9	5.8	5.4
Sp. Cond (uS)	41	110	63	74	68	22	24	32	23
TDS (mg/L)	30	59	23	42	25	9.5	10.5	20.5	16.5
ORP (V)	0.092	-0.06	0.05	-0.049	0.008	0.281	0.311	0.12	0.199
Eh (mV)	291	139	249	150	207	480	510	319	398
DO (mg/L)	0.08	0.02	0.2	0.02	0.09	8.64	9.5	6.14	10.77
Cations									
Ca 2+ (mg/l)	1.60	15.00	5.10	3.40	5.20	0.63	0.75	0.78	0.57
Mg 2+ (mg/l)	0.46	0.68	0.86	0.76	0.35	0.46	0.44	0.2	0.19
Na+ (mg/l)	1.2	1.9	0.82	1.7	2.8	0.69	0.76	2	0.89
K+ (mg/l)	0.96	4.3	3.2	7.6	3.4	0.2	0.21	0.3	0.26
Anions									
HCO3- (mg/l)	1.2	32.6	14.5	15.7	18.1	1.2		10.9	4.8
CO3 2- (mg/l)									
SO4 2- (mg/l)	9.5	13.8	11.2	11.5	11.4	0.14	0.2	1.3	0.8
Cl- (mg/l)	1.5	2.32	1.4	1.41	1.55	1.9	1.7	1.6	1.7
F- (mg/l)	<0.047	0.106	0.097	0.097	0.086	<0.047	0.049	<0.047	<0.047
NO3 2- (mg/l)									
Ion Balance	-14.5	5.5	-7.5	-4	-7.9	15.6	34.1	-25.2	-23.3

appendix III Table 1. Field and major ion data

Well No.	P16TA	P17A	P17TD	P17TC	P17TB	P17TA	P18A	P18TD	P18TC
Screened elevation	-354	37	-73	-283	-363	-522	16	-185	-263
Unit	I/IIA	IIA	CI-II	IB	IA	IA	CI-II	IB	IB
Sample date	2/4/89	2/11/89	2/11/89	2/11/89	2/11/89	2/11/89	12/17/88	12/17/88	12/17/88
Temp. (oC)	20.9	19.5	19.8	20.7	21.1	21.6	20	21.9	21.5
pH units	5.6	6.8	5.6	5.8	5.2	4.9	7.2	6.4	6.2
Sp. Cond (uS)	30	107	54	56	42	45	203	103	76
TDS (mg/L)	16.5	67.5	32.5	33.5	29	30.5	113	60	59
ORP (V)	0.179	0.09	0.069	0.057	0.097	0.112	0.259	-0.016	0.017
Eh (mV)	378	289	268	256	296	311	458	183	216
DO (mg/L)	6.06	6.44	0.02	0.02	0.04	0.04	3.99	2.53	0.25
Cations									
Ca 2+ (mg/l)	0.67	20.00	6.10	7.60	4.00	2.00	39.00	17.00	12.00
Mg 2+ (mg/l)	0.22	0.59	0.44	0.38	0.27	0.42	0.76	0.56	0.42
Na+ (mg/l)	0.89	0.88	0.9	0.59	0.6	1.1	1.7	1.2	0.86
K+ (mg/l)	0.46	0.88	0.69	0.64	0.52	0.82	3.8	1	0.68
Anions									
HCO3- (mg/l)	7.2	53.1	13.3	12.1	3.6	0	105	43.5	24.1
CO3 2- (mg/l)									
SO4 2- (mg/l)	1.7	3.7	6.46	8.75	9.44	11.1	6.3	8.2	8.9
Cl- (mg/l)	1.7	1.69	2.25	1.67	1.58	1.7	2.6	1.9	1.9
F- (mg/l)	<0.047	0.153	0.048	<0.047	<0.047	<0.047	<0.047	0.095	0.062
NO3 2- (mg/l)									
Ion Balance	-32.7	4.9	-2.6	2.8	-7	-15.8	6.2	1.6	3.8

appendix III Table 1. Field and major ion data

Well No.	P18TB	P18TA	P19D	P19C	P19B	P19TD	P19TA	P10A	P20C
Screened elevation	-375	-544	262	120	68	-133	-464	-549	142
Unit	IA	IA	WT	IIB	IIA	CI-II	IA	IA	IIB
Sample date	12/17/88	12/17/88	12/7/88	12/7/88	12/7/88	12/14/88	12/7/88	12/14/88	1/7/89
Temp. (oC)	21	22.2	20.2	18.7	18.6	20.4	22.1	22.1	20.2
pH units	6.1	5.4	5	4.9	5	5.6	6.3	4.9	6.6
Sp. Cond (uS)	66	52	29	24	24	58	77	37	87
TDS (mg/L)	42	44	<5.	5	11	56	31	63	61
ORP (V)	0.003	0.061	0.183	0.346	0.264	-0.02	-0.019	0.013	-0.049
Eh (mV)	202	260	382	545	463	179	180	212	150
DO (mg/L)	0.04	0.04	6.27	8.89	8.92	0.04	0.08	0.08	0.41
Cations									
Ca 2+ (mg/l)	6.90	3.70	0.81	0.38	0.35	8.30	8.00	1.20	11.00
Mg 2+ (mg/l)	0.4	0.53	0.33	0.24	0.3	0.37	0.29	0.33	0.33
Na+ (mg/l)	0.89	1.3	1.7	1.4	1.4	0.78	2.2	1.3	2.8
K+ (mg/l)	0.71	1.2	0.12	0.86	0.7	0.68	2.6	1.2	2.9
Anions									
HCO3- (mg/l)	18.1	4.8	1.2	2.4	1.2	12.1	20.5	1.2	41.1
CO3 2- (mg/l)									
SO4 2- (mg/l)	10.2	11.6	1.09	0.75	0.33	9.3	11	10.5	1.7
Cl- (mg/l)	1.7	1.7	2.34	2.24	2.32	2.1	1.63	1.5	2.2
F- (mg/l)	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047	0.102	0.051	0.047
NO3 2- (mg/l)									
Ion Balance	-12.4	-7.8	14.6	1.7	13.6	4.8	-2.6	-23.9	-0.1

appendix III Table 1. Field and major ion data

Well No.	P20B	P20TD	P21D	P21B	P21A	P21TD	P21TC	P21TB	P5A
Screened elevation	38	-273	137	-77	-150	-273	-466	-604	-772
Unit	IIA	IB	WT	IIA	CI-II	IB	IB	IA	IA
Sample date	1/7/89	1/7/89	2/17/89	2/17/89	2/12/89	2/12/89	2/17/89	2/12/89	2/17/89
Temp. (oC)	20.3	20.4	18.3	20.4	20.1	21.6	22.3	23.3	23.5
pH units	7.6	6.2	6.3	6.7	6.7	6.1	6.4	6.8	6.1
Sp. Cond (uS)	216	76	81	158	157	92	98	109	72
TDS (mg/L)	150	52.5	5	104.5	102	58	67.5	66	54.5
ORP (V)	-0.086	0.001	0.132	-0.03	-0.104	-0.024	-0.036	-0.084	0.002
Eh (mV)	113	200	331	169	95	175	163	115	201
DO (mg/L)	4.33	0.11	7.54	0.04	0.02	0.04	0.25	0.07	0.15
Cations									
Ca 2+ (mg/l)	45.00	11.00	12.00	31.00	27.00	12.00	10.00	10.00	3.60
Mg 2+ (mg/l)	0.96	0.51	0.74	0.94	1.1	0.94	2.2	2.1	0.42
Na+ (mg/l)	1.8	1	2	1.8	1.2	0.91	1.2	2.4	3.8
K+ (mg/l)	1.6	1	0.46	1.4	1.4	2.1	4.8	6.5	4.4
Anions									
HCO3- (mg/l)	113.5	25.4	30.2	80.9	78.5	33.8	45.9	41.1	21.7
CO3 2- (mg/l)									
SO4 2- (mg/l)	11.9	8.6	1.77	1.23	9.77	9.82	8.77	11.3	13.3
Cl- (mg/l)	2.4	1.9	4.7	2.74	2.59	2.03	2.03	1.56	1.69
F- (mg/l)	0.075	0.072	<0.047	0.079	0.049	<0.047	0.12	0.063	0.064
NO3 2- (mg/l)									
Ion Balance	5.7	0.5	6.6	9.6	-1.3	-3	-7.7	-0.7	-16.3

appendix III Table 1. Field and major ion data

Well No.	P22D	P22C	P22TD	P22TC	P22TA	P23B	P23A	P23TD	P23TC
Screened elevation	165	84	-314	-421	-725	46	-31	-232	-402
Unit	WT	CIIA-IIB	IB	IB	IA	IIA	CI-II	IB	IB
Sample date	2/22/89	2/22/89	2/22/89	2/22/89	2/22/89	2/26/89	2/26/89	2/26/89	2/26/89
Temp. (oC)	19.7	19	21.1	21.7	23.1	19.8	20.3	21.5	21.9
pH units	5.9	5.8	6.1	6.2	5.8	7.1	6.3	6.2	6.3
Sp. Cond (uS)	34	39	76	84	63	184	104	80	83
TDS (mg/L)	13	19	52	55.5	39.5	138	90	58	81
ORP (V)	0.117	0.228	-0.022	-0.012	0.049	-0.084	0	0.014	-0.041
Eh (mV)	316	427	177	187	248	115	199	213	158
DO (mg/L)	8.43	9.98	0.02	0.06	0.14	0.02	0.19	0.05	0.05
Cations									
Ca 2+ (mg/l)	4.00	4.40	10.00	11.00	3.70	35.00	16.00	10.00	5.30
Mg 2+ (mg/l)	0.38	0.38	0.42	0.95	0.56	0.77	0.69	0.69	1.4
Na+ (mg/l)	0.66	0.9	0.64	0.75	1.4	1.1	0.83	0.69	2.3
K+ (mg/l)	0.4	0.52	1.3	2.4	4	0.64	1.6	5.2	5.8
Anions									
HCO3- (mg/l)	10.9	12.1	29	31.4	14.5	90.6	41.1	26.6	25.4
CO3 2- (mg/l)									
SO4 2- (mg/l)	0.39	0.68	7.92	8.82	11.2	10.3	10.2	9.12	11.8
Cl- (mg/l)	2.09	2.61	1.97	2.02	1.88	2.4	2.12	1.71	1.37
F- (mg/l)	0.067	0.098	0.054	0.093	0.101	0.052	0.064	<0.047	0.069
NO3 2- (mg/l)									
Ion Balance	4	2	-8	-2.6	-14.6	2.9	-0.9	3.2	-5.7

appendix III Table 1. Field and major ion data

Well No.	P23TB	P23TA	P24D	P24C	P24TD	P24TC	P24TB	P24TA	P25C
Screened elevation	-511	-626	258	168	-182	-276	-487	-648	105
Unit	IA	IA	WT	IIB	IB	IB	IA	IA	IIB
Sample date	2/26/89	2/26/89	2/8/89	2/8/89	2/8/89	2/8/89	2/8/89	11/30/88	11/20/88
Temp. (oC)	22.5	22.9	19.9	20.4	21.3	21.1	21.9	22.3	20
pH units	5.8	6	5.7	7	6.4	6	6	6	7.6
Sp. Cond (uS)	65	67	69	54	94	70	63	60	192
TDS (mg/L)	69	68	53	50	74.5	56.5	52	34.5	86
ORP (V)	0.035	0.008	0.092	0.126	-0.007	0.033	-0.026	-0.008	0.081
Eh (mV)	234	207	291	325	192	232	173	191	280
DO (mg/L)	0.05	0.07	7.69	9.82	1.69	0.24	0.02	0.02	8.07
Cations									
Ca 2+ (mg/l)	2.50	1.60	5.30	7.20	16.00	8.90	5.60	2.40	38.00
Mg 2+ (mg/l)	0.62	0.39	0.66	0.24	0.47	0.51	0.53	0.35	0.64
Na+ (mg/l)	3	3.5	3.3	1.2	0.79	0.87	0.73	1.8	1.6
K+ (mg/l)	4.8	4.5	2.2	1.5	1.6	1.5	1.8	1.8	0.43
Anions									
HCO3- (mg/l)	13.3	14.5	14.5	20.5	37.4	22.9	15.7	10.9	101.4
CO3 2- (mg/l)									
SO4 2- (mg/l)	12.6	12.3	0.6	0.73	8.52	8.05	9.99	11	1.22
Cl- (mg/l)	1.3	1.31	7.58	1.95	1.97	1.96	1.64	1.5	2.79
F- (mg/l)	0.049	0.055	<0.047	<0.047	0.048	0.054	0.084	0.069	0.038
NO3 2- (mg/l)									
Ion Balance	-9.6	-17	5.6	7.3	3.6	-3.4	-12.5	-24.9	6.9

appendix III Table 1. Field and major ion data

Well No.	P25A	P25TE	P25TD	P25TB	P25TA	P26D	P26B	P26A	P26TD
Screened elevation	-39	-140	-200	-460	-594	111	76	26	-94
Unit	CI-II	CI-II	IB	IA	IA	WT	CIIA-IIB	IIA	IB
Sample date	11/20/88	11/20/88	11/20/88	11/20/88	11/20/88	2/10/89	2/10/89	2/10/89	2/10/89
Temp. (oC)	20.8	20.6	21	22	22.4	19.2	20	19.3	20.5
pH units	6.5	5.9	6.2	6.1	5.7	5.8	6.6	5.3	5.6
Sp. Cond (uS)	111	70	88	83	63	50	75	43	59
TDS (mg/L)	44	20	31	26	31	27	44	49	34.5
ORP (V)	0.004	0	0.033	0.059	0.042	0.235	0.165	0.129	0.088
Eh (mV)	203	199	232	258	241	434	364	328	287
DO (mg/L)	2.32	0.04	1.21	0.02	0.06	9.91	5.35	0.04	0.06
Cations									
Ca 2+ (mg/l)	17.00	8.40	14.00	6.60	1.90	6.40	12.00	3.60	5.80
Mg 2+ (mg/l)	0.65	0.56	0.51	1.2	0.3	0.62	0.47	0.54	0.73
Na+ (mg/l)	1.8	1	1.1	1.7	3.5	1.1	1.4	0.75	0.77
K+ (mg/l)	1.6	2.2	1.6	5.6	3.1	0.73	1.6	1.4	2.2
Anions									
HCO3- (mg/l)	44.7	20.5	30.2	24.1	12.1	20.5	30.2	6	12.1
CO3 2- (mg/l)									
SO4 2- (mg/l)	10.6	8.55	9.05	11.7	11.5	0.83	2.74	6.34	9.62
Cl- (mg/l)	2.06	1.81	1.82	1.59	1.58	2.56	2.43	1.99	1.82
F- (mg/l)	0.066	0.059	0.048	0.065	0.062	<0.047	<0.047	0.064	0.052
NO3 2- (mg/l)									
Ion Balance	0.3	-0.3	5.9	-3.2	-16.1	1.4	8.7	0.3	-1.6

appendix III Table 1. Field and major ion data

Well No.	P26TB	P26TA	P27D	P27C	P27B	P27TC	P27TA	FC2E	FC2D
Screened elevation	-378	-533	209	142	84	-291	-538	192	162
Unit	IA	IA	WT	IIB	IIA	IB	IA	IIB	CIIA-IIB
Sample date	3/19/89	3/19/89	2/20/89	2/20/89	2/20/89	2/20/89	2/20/89	2/5/89	2/5/89
Temp. (oC)	21	21.6	19	19.6	19	21	21.6	20.4	20
pH units	6.9	6.1	5.4	7	6.4	6.4	5	5.4	6.8
Sp. Cond (uS)	108	75	33	122	80	79	45	85	102
TDS (mg/L)	77	57.5	35	82	50.5	48.5	28	42	55
ORP (V)	-0.092	-0.034	0.17	0.051	0.207	0	0.082	0.239	0.067
Eh (mV)	107	165	369	250	406	199	281	438	266
DO (mg/L)	0.11	0.06	1.23	3.34	8.11	0.81	0.02	5.62	6.7
Cations									
Ca 2+ (mg/l)	4.20	1.50	2.50	18.00	12.00	12.00	1.60	2.20	17.00
Mg 2+ (mg/l)	0.7	0.42	0.41	0.43	0.32	0.34	0.39	1.3	0.43
Na+ (mg/l)	0.77	0.46	0.97	2	1.5	0.8	1	6.4	1.5
K+ (mg/l)	8.1	4.1	0.49	2.5	1.4	1.4	1.4	1.3	0.88
Anions									
HCO3- (mg/l)	38.6	20.5	6	54.3	37.4	25.4	1.2	3.6	47.1
CO3 2- (mg/l)									
SO4 2- (mg/l)	11.5	11.8	0.63	1.63	1.4	11.1	11.9	21.6	1.7
Cl- (mg/l)	1.58	1.61	3.33	2.88	3.31	1.83	2.01	2.2	2.5
F- (mg/l)	0.11	0.055	<0.047	0.343	0.089	0.067	<0.047	<0.047	<0.047
NO3 2- (mg/l)									
Ion Balance	-29	-45.8	1.9	2.9	-1	-0.4	-25.8	-3.9	5

appendix III Table 1. Field and major ion data

Well No.	FC2A	P28A	P28TE	P28TB	P28TA	P29D	P29C	P29B	P29A
Screened elevation	55	-52	-129	-347	-478	163	131	72	-44
Unit	CI-II	CI-II	IB	IA	IA	WT	IIA	IIA	CI-II
Sample date	2/5/89	2/5/89	2/5/89	2/5/89	11/30/88	2/19/89	2/19/89	2/19/89	2/19/89
Temp. (oC)	19.8	20.2	20.4	21.3	21.8	20.8	19.3	20.2	20.7
pH units	6.3	6	6.5	5.5	5.5	5.4	5.7	6.2	6.3
Sp. Cond (uS)	98	69	79	45	35	43	66	57	67
TDS (mg/L)	68.5	39	50.5	30	18	15	28	36	36.5
ORP (V)	-0.004	0.044	0.022	0.037	0.154	0.237	0.117	0.173	0.064
Eh (mV)	195	243	221	236	353	436	316	372	263
DO (mg/L)	0.01	0.02	0.36	0.06	3.87	7.33	1.93	8.08	2.25
Cations									
Ca 2+ (mg/l)	15.00	9.20	13.00	1.80	4.00	3.00	9.00	8.30	11.00
Mg 2+ (mg/l)	0.54	0.51	0.4	0.35	0.24	0.38	0.48	0.42	0.24
Na+ (mg/l)	0.97	0.72	0.67	0.89	1	2.3	0.87	0.87	0.76
K+ (mg/l)	1.7	1	0.76	0.71	4.2	0.34	0.35	0.47	0.34
Anions									
HCO3- (mg/l)	35	18.1	24.1	6	7.2	9.7	26.6	20.5	25.4
CO3 2- (mg/l)									
SO4 2- (mg/l)	9.3	9.3	9.8	8.2	4.41	2.3	0.63	0.69	7.21
Cl- (mg/l)	2.1	1.7	1.5	1.7	2	4.38	2.54	1.94	2.11
F- (mg/l)	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047	<0.047
NO3 2- (mg/l)									
Ion Balance	3	1.8	6.5	-28.9	16.4	-6.5	1.3	10.4	-1.3

appendix III Table 1. Field and major ion data

Well No.	P29TC	P29TA	P30TA	C2	C-3	C-5	C-6	905-94K	MR-H
Screened elevation	-234	-414	-340	-105	-193	-572	-830		?
Unit	CIA-IB	IA	I/IIA	I/IIA	I/IIA	CI	IA		I/II
Sample date	2/19/89	11/29/88	3/19/89	11/29/88	12/1/88	12/1/88	12/1/88	1/20/89	4/26/89
Temp. (oC)	20.6	21	20.3	20.4	20.5	22.5	23.1		17.8
pH units	5.8	5.5	5.2	5.6	5.8	5.4	6.2		4.8
Sp. Cond (uS)	46	28	23	31	48	54	84		24
TDS (mg/L)	31	18.5	25.5	18.5	29	29.5	49.5		11
ORP (V)	0.122	0.146	0.187	0.201	0.153	-0.032	-0.073		0.356
Eh (mV)	321	345	386	400	352	167	126	199	555
DO (mg/L)	5.36	5.7	6.99	7.25	5.05	0.02	0.01		8.37
Cations									
Ca 2+ (mg/l)	4.60	0.55	0.47	2.40	3.20	2.90	4.60		0.29
Mg 2+ (mg/l)	0.13	0.23	0.23	0.24	0.3	0.39	0.79		0.55
Na+ (mg/l)	1.9	1.2	<0.1	1.2	2.3	2.3	2.6		<0.1
K+ (mg/l)	0.28	0.34	0.28	0.59	1.2	1.1	6.1		0.38
Anions									
HCO3- (mg/l)	14.5	6	3.6	24.1	0	0	0	0	43.5
CO3 2- (mg/l)									
SO4 2- (mg/l)	4.9	1.62	1.1	1.96	6.51	12.1	13		0.16
Cl- (mg/l)	2.19	1.98	1.86	1.75	1.7	1.57	1.82		2.2
F- (mg/l)	<0.047	<0.047	<0.045	<0.047	<0.047	0.05	0.086		<0.047
NO3 2- (mg/l)									
Ion Balance	-9.7	-27.5	-45.7	-0.2	-6.9	-10.7	-12.3		3

appendix III Table 1. Field and major ion data

Well No.	FMC-K	EL-H	DI-K	C10	C10	CW-1	CA-1
Screened elevation	315	?	310	-1120	-1120	130	106
Unit	I/II	I/II	I/II	IA	IA	I/II	I/II
Sample date	4/26/89	4/26/89	4/26/89	2/28/89	2/16/89	11/29/88	11/29/88
Temp. (oC)	19.7	19.7	18.9	27.1	27.1	19.2	19.2
pH units	4.59	4.7	4.4	6.9	6.9	4.8	5
Sp. Cond (uS)	19	23	38	107	108	18	25
TDS (mg/L)	11.5	12	20	77.5	103	10.5	19
ORP (V)	0.331	0.363	0.408	-0.044	-0.062	0.36	0.276
Eh (mV)	530	562	607	155	137	559	475
DO (mg/L)	9.41	9.03	8.07	0.15	0.04	8.6	8.72
Cations							
Ca^{2+} (mg/l)	0.31	0.20	0.43	0.90	1.10	0.24	0.80
Mg^{2+} (mg/l)	0.2	0.3	0.72	0.14	0.16	0.11	0.29
Na^{+} (mg/l)	<0.1	<0.1	0.15	18	15	0.85	1.7
K^{+} (mg/l)	0.22	0.26	0.4	3.6	3.6	0.18	0.2
Anions							
HCO_3^{-} (mg/l)	45.9						
CO_3^{2-} (mg/l)							
SO_4^{2-} (mg/l)	0.79	0.16	0.21	11.6	12.1	1.07	0.53
Cl^{-} (mg/l)	1.4	1.6	3.1	2.24	2.33	1.43	1.77
F^{-} (mg/l)	<0.047	<0.047	<0.047	0.064	0.058	<0.047	<0.047
NO_3^{2-} (mg/l)							
Ion Balance	-19.1	-7.9	2.6	-4.6	-13.8	0	40.2

Appendix III. Table 2. Isotopic Data for water samples

WELL NO.	del-O18	del-D	Tritium		del-C13	Fmc	ALPHA	BETA
UNITS	PPT/SMOW	PPT/SMOW	TU	error		corrected	pci/l	pci/l
	UGA	UGA	UW		UA	UA	Conoco	Conoco
P13C	-4.5	-19				0.9990	<2.	<4.
P13A	-4.6	-22					<2.	<4.
P13TD	-4.0	-25					<2.	8.2
P13TC	-4.0	-27					3.2	7.9
P13TA	-4.1	-19					<2.	4.4
IDB-IC	-4.8	-22					2.5	<4.
P14C	-4.9	-21					<2.	<4.
P14TC	-4.8	-28					4	5.9
P14TB	-4.8	-27					<2.	<4.
P14TA	-4.6	-29					2.5	5.3
P15A	-4.6	-21					<2.	<4.
P15TC	-4.0	-17					<2.	4.4
P15TB	-4.1	-19					2.2	6.6
P15TA	-4.2	-16					<2.	5.1
P16B	-4.9	-28	584.1		-22.13	0.8971	3.4	<4.
P16A	-5.0	-18	364.6		-22.47	0.8637	<2.	<4.
P16TC	-4.9	-24	1.1	0.7			<2.	<4.
P16TB	-4.6	-19	<0.8		-21.26	0.8973	<2.	<4.
P16TA	-4.6	-22	<0.8	0.7	-21.23	0.7028	4.3	<4.
P17A	-4.8	-26	1.3	0.4		0.5313	<2.	<4.
P17TD	-4.1	-22	1.7	0.6	-20.11	0.7289	<2.	<4.
P17TC	-4.8	-21	<0.8	0.8			<2.	<4.
P17TB	-5.0	-26	<0.8	0.6			4.5	6.3
P17TA	-4.6	-19	0.9	0.6	-25.00	0.5292	4.3	6.1
P18A	-4.5	-20					<2.	<4.
P18TD	-4.4	-22					<2.	<4.
P18TC	-4.3	-27					2	<4.
P18TB	-4.4	-22					-19	<4.
P18TA	-4.3	-29					2	<4.
P19D	-4.6	-28					<2.	<4.
P19C	-4.8	-26					<2.	<4.
P19B	-4.7	-22					<2.	<4.
P19TD	-4.4	-19					<2.	<4.
P19TA	-4.3	-22					3.7	5
P10A	-4.9	-23					<2.	<4.
P20C	-4.3	-18						
P20B	-4.5	-27						
P20TD	-4.4	-28						
P21D	-4.6	-28	238.3	15.6	-20.31	0.8948	<2.	<4.
P21B	-4.5	-21			-14.10	0.3217	<2.	<4.
P21A	-4.3	-23	1.6	0.6	-26.40	0.3182	<2.	<4.
P21TD	-4.4	-17	1.4	0.6	-19.50	0.2003	2.6	7.7
P21TC	-4.0	-20	<0.8	0.6		0.2844	<2.	4.5
P21TB	-5.1	-28	<0.8	0.7			<2.	8.9

Appendix III. Table 2. Isotopic Data for water samples

WELL NO.	del-O18	del-D	Tritium		del-C13	Fmc	ALPHA	BETA
UNITS	PPT/SMOW	PPT/SMOW	TU	error		corrected	pci/l	pci/l
	UGA	UGA	UW		UA	UA	Conoco	Conoco
P5A	-4.3	-21	<0.8	0.8	-21.37	0.2053	<2.	4.2
P22D	-4.9	-28			-21.71	0.8463	<2.	<4.
P22C	-4.5	-28	2.8	0.6	-20.97	0.8361	<2.	<4.
P22TD	-4.0	-21	2.4	0.7			<2.	<4.
P22TC	-4.1	-21	1.3	0.6		0.3635	<2.	4.1
P22TA	-4.2	-19	1.2	0.7		0.3545	<2.	7.1
P23B	-4.3	-20	0.9	0.7			<2.	<4.
P23A	-4.2	-23	<.0.8	0.7	-17.33		<2.	<4.
P23TD	-4.0	-24	2.2	0.6			<2.	<4.
P23TC	-4.6	-25	<0.8	0.5			<2.	6.5
P23TB	-4.4	-26	<0.8	0.6		0.1759	<2.	4.6
P23TA	-4.3	-21	1.8	0.6		0.1857	<2.	<4.
P24D	-4.7	-20			-20.85	1.1644	<2.	<4.
P24C	-4.6	-23	258.1	15.0		0.9162	<2.	<4.
P24TD	-4.4	-23	1.3	0.6		0.4636	<2.	<4.
P24TC	-4.2	-21	4.3	0.7		0.5283	<2.	<4.
P24TB	-4.2	-24	1.1	0.6	-22.40	0.4279	<2.	<4.
P24TA	-4.2	-18			-20.22	0.3669		
P25C	-4.4	-22					<2.	<4.
P25A	-4.1	-23					<2.	<4.
P25TE	-4.0	-23					4.2	7.3
P25TD	-4.2	-19					<2.	<4.
P25TB	-4.4	-22					<2.	7.2
P25TA	-4.1	-19					<2.	<4.
P26D	-4.7	-20			-20.29	0.9989	<2.	<4.
P26B	-4.9	-26	1761.0	###	-10.92	0.9915	<2.	<4.
P26A	-3.7	-21	<0.8		-20.72	0.8288	<2.	<4.
P26TD	-4.0	-22	<0.8			0.3290	3.5	<4.
P26TB	-4.9	-24	2.0	0.6		0.1270	<2.	7.8
P26TA	-4.4	-25	<0.8	0.8		0.1770	<2.	4.6
P27D	-3.9	-21			-20.15	0.8756	<2.	<4.
P27C	-3.5	-16	17.2	1.4	-21.20	0.7963	<2.	<4.
P27B	-4.6	-22	7.8	0.8	-20.23	0.7708	<2.	<4.
P27TC	-4.9	-24	1.7	0.6		0.6359	<2.	<4.
P27TA	-4.4	-22	0.9	0.6			<2.	<4.
FC2E	-4.8	-25			-21.32	1.0403	<2.	5.4
FC2D	-4.4	-28			-18.75	0.8312	<2.	<4.
FC2A	-4.3	-20			-17.35	0.4721	2	<4.
P28A	-4.5	-26			-18.52	0.5399	<2.	<4.
P28TE	-4.5	-27			-25.00		<2.	<4.
P28TB	-4.6	-25	1.7	0.8	-21.50	0.6055	<2.	<4.
P28TA	-4.9	-22			-20.59	0.7717		
P29D	-4.6	-24			-22.54	1.1007	<2.	<4.
P29C	-4.8	-26	986.7	63.0	-24.19	0.7504	<2.	<4.

Appendix III. Table 2. Isotopic Data for water samples

WELL NO. UNITS	**del-O18** PPT/SMOW UGA	**del-D** PPT/SMOW UGA	**Tritium** TU UW	error	**del-C13** UA	**Fmc** corrected UA	**ALPHA** pci/l Conoco	**BETA** pci/l Conoco
P29B	-4.7	-21	604.0	50.0	-21.71	0.9156	2.4	<4.
P29A	-4.6	-23	0.9	0.6	-21.28	0.7235	3.9	<4.
P29TC	-4.8	-28	0.8	0.6		0.7185	<2.	<4.
P29TA	-4.8	-24			-21.34	0.8080	<2.	<4.
P30TA	-5.0	-23	1.3	0.8		0.8660	<2.	<4.
FB2								
FB1								
P31	-4.8	-18						
C-2	-4.7	-26			-14.31	0.8297	<2.	<4.
C-3	-4.7	-29			-21.01	0.6500		
C-5	-4.4	-29			-20.63	0.5183		
C-6	-4.0	-18						
905-94K	-4.0	-23						
MR-H	-5.5	-30	170.5	9.0		1.1440		
FMC-K	-5.1	-21	87.6	5.0		0.9490		
EL-H	-5.0	-24	121.9	8.0		1.0010		
DI-K	-5.0	-21	135.5	1.0		1.0530		
C10	-5.1	-28	1.3	0.6	-21.40	0.1110	2.1	4.4
C10	-5.2	-29	0.8	1.8	-25.00	0.0990	<2.	<4.
CW-1	-4.8	-20			-21.99	0.9043	<2.	<4.
CA-1	-4.9	-26			-15.13	0.8106	3	<4.

total no. 60
C10*= duplicate analysis?
**** C13 = -25.00 assumed**

AppendixIII, table 3: Minor and Trace Constituents

		P13TA	P13TC	P13TD	P15TB	P15A	P15TA	P15TC	P25A	P25C	P25TA
Ag	(mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Al	(mg/l)	0.0022	0.0048	0.0153	0.0025	0.0023	<0.001	0.0129	0.0124	0.0089	0.0043
As	"	0.0025	0.0026	0.0026	<0.0008	0.0012	<0.0008	<0.0008	0.0019	<0.0008	<0.0008
B	"										
Ba	"	0.034	0.064	0.047	0.067	0.037	0.033	0.062	0.028	<0.005	0.023
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	0.00008	0.00008	<0.00005	<0.00005	<0.00005	0.00006	0.00028	0.0001	<0.00005	<0.00005
Co	"	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cr	"	0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003		<0.0003
Fe	"	2.4	2.1	0.69	1.6	0.71	1.7	2.3	0.64	<0.03	2.8
I	"	0.0066	0.0081	0.013	0.013	0.016	0.01	0.009	0.012	0.0078	0.01
Mn	"	0.043	0.084	0.057	0.064	0.047	0.032	0.065	0.053	<0.01	0.046
Mo	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ni	"	<0.0003	<0.0003	0.0175	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007
Sb	"										
Se	"	<0.001	<0.001	<0.001	<0.001	0.0031	<0.001	<0.001	<0.001	<0.001	<0.001
Si	"	5.1	5.7	6.7	5.4	6.4	4.9	5.1	4.9	4.3	4.8
SiO2	"	11.3	12.9	15.5	12.2	14.2	10.6	10.9	11.6	9.66	10.3
Sn	"	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Sr	"	0.016	0.081	0.061	0.049	0.2	0.062	0.023	0.09	0.032	0.021
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
TOC	"	0.6	0.5	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2
U	"	0.0046	0.003	0.004	0.0032	0.005	0.0026	0.0018	0.0024	0.005	0.0013
Zn	"	0.005	0.0027	0.0026	0.0022	0.0014	0.0032	0.0017	0.0034	<0.001	0.0042

Appendix III, table 3: Minor and Trace Constituents

		P25TB	P25TD	P25TE	C2	CA-1	CW-1	P29TA	P24TA	P28TA	C-3
Ag	(mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Al	(mg/l)	0.0025	0.0058	0.0108	0.0113	0.0036	0.0042	<0.001	0.0159	0.0291	0.0063
As	"	<0.0008	0.0022	<0.0008	0.0009	<0.0008	<0.0008	<0.0008	<0.0007	<0.0007	<0.0007
B	"										
Ba	"	0.085	0.026	0.026	0.013	0.0067	0.0048	0.007	0.016	0.006	0.006
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	<0.00005	0.00008	<0.00005	<0.00005	<0.00005	0.00014	0.00016	<0.00005	<0.00005	<0.00005
Co	"	<0.01	<0.01	<0.01					<0.01	<0.01	<0.01
Cr	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0004	<0.0004	<0.0004
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	0.122	0.0346	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	2	0.46	0.98	0.0584	0.0181	0.0156	1.31	4.9	0.24	<0.03
I	"	0.012	0.012	0.012	0.0059	0.0035	0.004	0.0065	0.01	0.008	0.0099
Mn	"	0.085	0.018	0.048	0.014	0.0025	0.0021	0.034	0.074	0.046	0.014
Mo	"	<0.005	<0.005	<0.005					<0.005	<0.005	<0.005
Ni	"	<0.0003	<0.0003	<0.0003	<0.0003	0.0021	<0.0003	0.0052	<0.0003	0.0041	<0.0003
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.0007	<0.0007	<0.0007	0.0025	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.0015
Sb	"										
Se	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Si	"	4.8	4.9	4.9	4.3	3.3	3.5	3.9	5.2	4.5	5.5
SiO2	"	10.4	11.1	11	9.32	7.17	7.53	8.3	9.72	8.36	10.6
Sn	"	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Sr	"	0.063	0.077	0.071	0.022	<0.005	<0.005	0.006	0.016	0.005	0.029
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
TOC	"	0.2	0.2	0.2	0.4	0.4	0.3	0.6	0.2	0.3	0.6
U	"	0.0027	0.003	<0.001	0.0024	0.0012	<0.001	0.0014	<0.001	<0.001	0.0054
Zn	"	0.0014	0.0028	0.0034	1.2	1.2	0.03	<0.025	0.029	<0.025	0.91

Appendix III, table 3: Minor and Trace Constituents

		C-5	C-6	P19B	P19C	P19D	P19TA	P10A	P19TD	P18A	P18TA
Ag	(mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0974	0.0062	0.0107	0.01	0.0232	0.0212	0.1177	0.0077	0.0391	0.0174
As	"	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.00084	0.0028	0.0025	<0.00084
B	"										
Ba	"	0.006	0.12	0.019	0.015	0.009	0.015	0.012	0.029	0.04	0.014
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00024	0.0002	<0.00005	0.00018
Co	"	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cr	"	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0012	<0.0003	0.0003	<0.0003
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003				
Fe	"	0.52	1.1	0.0029	0.0039	0.0137	0.832	2.5	0.54	<0.03	1.6
I	"	0.011	0.0096	0.0048	0.0046	0.0048	0.011	0.0082	0.0098	0.0058	0.0049
Mn	"	0.021	0.039	0.0022	0.002	0.0028	0.019	0.038	0.021	<0.01	0.072
Mo	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ni	"	0.0035	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0004	<0.0002	<0.0002	0.0048
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.0007	<0.0007	0.0021	0.0009	0.0028	0.0012	<0.0006	<0.0006	<0.0006	<0.0006
Sb	"										
Se	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0009	0.0017	<0.0009	<0.0009
Si	"	5.7	7.4	4.7	4.9	2.5	5.1	5	6.2	8.9	5.1
SiO2	"	10.9	14.2	7.86	8.15	4.17	8.69	8.62	10.82	15.52	8.73
Sn	"	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Sr	"	0.02	0.051	0.007	0.005	<0.005	0.082	<0.005	0.051	0.14	0.023
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
TOC	"	0.3	0.2	0.3	0.4	0.3	0.6	<0.1	0.7	0.4	0.4
U	"	0.004	0.0015	0.0027	<0.001	<0.001	<0.001	<0.001	<0.001	0.0023	<0.001
Zn	"	0.91	2.8	0.0024	0.0029	0.0052	0.0059	0.083	0.0026	0.0017	0.0098

AppendixIII, table 3: Minor and Trace Constituents

		P18TB	P18TC	P18TD	IDB-IC	P14C	P14TA	P14TB	P14TC	P13A	P13C
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0054	0.0079	0.0073	0.0045	0.0052	0.046	0.0142	0.1668	0.0035	0.0108
As	"	<0.00084	0.0032	0.0021	0.0017	0.0025	<0.0007	0.0008	0.001	0.0011	0.0014
B	"										
Ba	"	0.026	0.023	0.032	0.007	0.022	0.01	0.023	0.01	0.056	0.023
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	0.00006	0.0001	<0.00005	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019
Co	"	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cr	"	<0.0003	<0.0003	<0.0003	<0.0003	0.0006	0.0006	<0.0003	<0.0003	<0.0003	<0.0003
Cu	"				<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	4	1	1.4	0.0025	0.0064	2.7	2.8	0.65	0.15	0.16
I	"	0.0076	0.006	0.0084							
Mn	"	0.11	0.029	0.056	<0.01	<0.01	0.045	0.058	0.034	0.11	0.033
Mo	"	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ni	"	0.0028	0.0031	<0.0002	0.0035	<0.0002	0.0048	0.0028	0.0031		<0.0002
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	0.28
Pb	"	<0.0006	<0.0006	<0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sb	"				<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Se	"	<0.0009	0.0022	<0.0009	0.0014	0.0021	<0.0009	<0.0009	<0.0009	0.0009	0.0021
Si	"	5	5.9	6.8	3.8	9.9	5.6	5.6	6	8.3	5.7
SiO2	"	8.01	11.7	10.13	5.65	15.3	8.47	8.41	9.11	12.6	8.45
Sn	"	<0.003	<0.003	<0.003	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037	<0.0037
Sr	"	0.076	0.1	0.11	0.008	0.12	0.017	0.059	0.07	0.064	0.028
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
TOC	"	0.6	0.6	0.7	0.51	0.64	0.55	0.37	0.73	0.31	0.92
U	"	<0.001	<0.001	<0.001	<0.001	0.0016	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	"	0.053	0.0058	0.18	<0.025	<0.025	<0.025	<0.025			<0.025

Appendix III, table 3: Minor and Trace Constituents

		P20B	P20C	P20TD	P31	FB1	FB2	P16A	P16B	P16TA	P16TB
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.03	<0.03	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0068	0.0182	0.0038	<0.001	<0.15	<0.15	0.0045	0.008	0.0057	0.0036
As	"	<0.0007	<0.0007	<0.0007	<0.0007			<0.001	<0.001	<0.001	<0.001
B	"					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.017	0.042	0.017	<0.005	<0.005	<0.005	0.007	0.009	0.006	0.006
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	3960	<0.059	<0.059	<0.059	<0.059
Cd	"	<0.00019	<0.00019	<0.00019	<0.00019	<0.015	<0.015	0.00036	0.00036	0.00064	0.00024
Co	"	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	"	0.0014	0.0019	<0.0003	<0.0003	<0.03	<0.03	<0.0002	<0.0002	<0.0002	<0.0002
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.015	<0.015	0.0031	0.0025	0.0024	0.0014
Fe	"	0.082	2.9	2.5	<0.0008	0.061	0.038	0.0009	0.0078	1.3	1.3
I	"							0.0055	0.0019	0.0075	0.0065
Mn	"	0.015	0.018	0.042	<0.01	<0.01	<0.01	<0.01	<0.01	0.044	0.039
Mo	"	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ni	"	<0.0002	<0.0002	0.0014	0.0019	<0.075	<0.075	<0.0007	<0.0007	<0.0007	0.0132
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<4.8	<0.019	<0.019	<0.019	<0.019
Pb	"	0.0006	<0.0005	<0.0005	0.0024	<0.25	<0.25	<0.001	<0.001	<0.001	0.0012
Sb	"	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25				
Se	"	<0.0009	<0.0009	<0.0009	<0.0009			<0.0016	<0.0016	<0.0016	<0.0016
Si	"	17	7.9	6.9	<0.25	<0.25	<0.25	1.9	1.7	3	2.6
SiO2	"	35.1	15.3	13.6	<0.53			6.44	5.43	9.88	8.45
Sn	"	<0.0037	<0.0037	<0.0037	<0.0037	<0.1	<0.1	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.28	0.18	0.064	<0.005	<0.005	<0.005	0.009	0.009	0.018	0.007
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.025	<0.025	<0.0006	<0.0006	<0.0006	<0.0006
TOC	"	0.97	0.68	0.82	0.82			1.4	1.1	0.5	1
U	"	0.0014	<0.001	<0.001	<0.001			<0.001	<0.001	0.0019	<0.001
Zn	"					<0.025	<0.025	<0.025	<0.025	<0.025	<0.025

AppendixIII, table 3: Minor and Trace Constituents

		P16TC	FC2A	FC2D	FC2E	P28A	P28TB	P28TE	P24C	P24D	P24TB
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0016
Al	(mg/l)	0.0033	0.0228	0.0078	0.0279	0.0033	0.0669	0.014	0.0158	0.0252	0.008
As	"	<0.001	0.0029	0.0014	<0.001	<0.001	<0.001	<0.001	<0.0018	<0.0018	<0.0018
B	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.006	0.03	0.009	0.021	0.018	0.009	0.017	0.049	0.058	0.031
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	0.00034	<0.0005	0.00162	0.00186	0.00028	0.00026	0.00024	0.0003	0.00036	0.00024
Co	"	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1			<0.1
Cr	"	<0.0002	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	"	0.0008	<0.0005	<0.0005	0.0022	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Fe	"	1.7	0.42	0.0022	0.098	1	3.9	0.12	0.0021	0.0021	3.8
I	"	0.011	0.0081	0.0088	0.055	0.016	0.011	0.0088	0.0085	0.017	0.0079
Mn	"	0.07	0.026	<0.01	0.11	0.033	0.05	<0.01	<0.01	<0.01	0.076
Mo	"	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05
Ni	"	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.0015	<0.0007	<0.0007	<0.0007	<0.0007
P-PO4	"	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.19	<0.19	<0.19
Pb	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0025	<0.0007	<0.0007
Sb	"										
Se	"	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016
Si	"	2.4	8.1	3.4	2	4	3.1	3.7	3	2.6	3.4
SiO2	"	8	28.8	11.9	6.87	13.6	12.8	12.8	10.5	9.16	11.5
Sn	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.012	0.12	0.035	0.013	0.025	0.024	0.054	0.044	0.041	0.032
Ti	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0009	<0.0009	<0.0009
TOC	"	0.8	0.7	0.5	0.7	0.8	0.5	0.5	1.1	0.6	0.5
U	"	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	"	<0.025	0.082	0.47	0.68	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025

Appendix III, table 3: Minor and Trace Constituents

		P24TC	P24TD	P26A	P26B	P26D	P26TD	P17A	P17TA	P17TB	P17TC
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0047	0.0188	0.0038	0.0115	0.0048	0.0027	0.0066	0.1934	0.1315	0.0103
As	"	<0.0018	<0.0018	0.0026	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016
B	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.034	0.073	0.028	0.021	0.015	0.052	0.008	0.009	0.009	0.014
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	0.0003	0.00022	<0.00005	<0.00005	<0.00005	<0.00005	0.00008	<0.00005	0.00008	0.00006
Co	"	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
Cr	"	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	"	<0.0005	<0.0005	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	1.3	0.52	0.86	0.0074	0.0074	1.2	0.0054	1.7	0.8	0.21
I	"	0.013	0.012	0.02	0.0085	0.011	0.01	0.0095	0.016	0.0058	0.0072
Mn	"	0.034	0.013	0.026	<0.01	<0.01	0.034	0.01	0.047	0.023	0.017
Mo	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05
Ni	"	<0.0007	<0.0007	0.0218	<0.0007	<0.0007	<0.0007	0.0066	<0.0007	0.0029	<0.0007
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.0007	<0.0007	<0.0006	<0.0006	<0.0006	<0.0006	0.0014	<0.0006	<0.0006	<0.0006
Sb	"			<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Se	"	<0.0016	<0.0016	<0.0014	<0.0014	<0.0014	<0.0014	0.0053	<0.0014	<0.0014	<0.0014
Si	"	3.7	5.1	9.2	2.7	2.7	3.4	4.4	3.2	3.1	3.6
SiO2	"	12.9	18.2	31.6	9.31	9.24	11.7	15.3	10.6	10.8	12.6
Sn	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.047	0.099	0.014	0.038	0.018	0.023	0.091	0.024	0.037	0.064
Ti	"	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
TOC	"	0.7	0.8	0.9	1.1	0.5	0.3	0.6	0.6	0.5	0.5
U	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	"	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025			<0.025	<0.025

Appendix III, table 3: Minor and Trace Constituents

		P17TD	P21A	P21TB	P21TD	C10	P21B	P21D	P21TC	P5A	P29A
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0089	0.0049	0.004	0.0019	0.0049	0.0038	0.0088	0.0096	0.0023	0.017
As	"	<0.0016	<0.0016	0.0024	<0.0016	0.0039	0.0024	<0.0013	<0.0013	0.002	<0.0013
B	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.013	0.076	0.082	0.064	0.01	0.038	0.01	0.1	0.045	0.006
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	0.00008	<0.00005	0.00006	0.00006	0.00026	0.00006	<0.00005	<0.00005	<0.00005	<0.00005
Co	"	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1
Cr	"	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	1.3	3.4	1.2	3.4	0.0014	0.33	0.0013	3.9	3.2	0.17
I	"	0.012	0.021	0.0056	0.02	0.0035	0.02	0.0097	0.021	0.011	0.0064
Mn	"	0.019	0.047	0.088	0.052	<0.01	0.021	0.01	0.078	0.083	0.034
Mo	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ni	"	0.0024	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.0006	<0.0006	<0.0006	<0.0006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	"	<0.25	<0.25	<0.25	<0.25						
Se	"	<0.0014	0.0029	0.0031	0.0041	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017
Si	"	3.5	6.8	3.8	3.7	4.6	5.2	2.6	4.4	3.6	2.9
SiO2	"	12	22.6	13.5	12.5	13.1	13.5	6.71	11.1	9.15	7.58
Sn	"	0.0004	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.036	0.13	0.1	0.05	0.038	0.14	0.04	0.084	0.025	0.089
Tl	"	<0.	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
TOC	"	0.4	0.4	1.5	0.7	1	0.9	0.7	0.8	1.1	0.7
U	"	<0.001	<0.001	<0.001	<0.001	0.0026	0.016	<0.001	<0.001	<0.001	0.0016
Zn	"	<0.025	<0.025	<0.025	<0.025	0.67	<0.025	0.18	<0.025	<0.025	<0.025

AppendixIII, table 3: Minor and Trace Constituents

		P29B	P29C	P29D	P29TC	P27B	P27C	P27D	P27TA	P27TC	P22C
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0069	0.0138	0.0106	0.0166	0.0328	0.0505	0.017	0.2177	0.0379	0.0035
As	"	<0.0013	0.0014	0.0019	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013
B	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.01	0.007	<0.005	<0.005	0.024	0.016	0.01	0.013	0.021	0.016
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	0.221	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	0.00006	<0.00005	<0.00005	<0.00005
Co	"	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	"	<0.0002	<0.0002	<0.0002	<0.0002	0.0013	0.0012	0.0002	<0.0002	<0.0002	0.0007
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	0.0018	1.4	0.0175	0.78	0.0063	0.0054	0.0083	2	0.33	0.0035
I	"	0.011	0.33	0.039	0.023	0.012	0.012	0.004	0.0064	0.012	0.016
Mn	"	<0.01	0.033	<0.01	0.035	0.01	<0.01	0.011	0.04	0.017	<0.01
Mo	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ni	"	0.0021	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.0038	<0.0007
P-PO4	"	<0.19	<0.19	<0.19	<0.19	<0.19	1.8	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	"										
Se	"	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017
Si	"	2.7	3	2.8	2.5	4.3	8.8	3.8	3.3	4.3	3.1
SiO2	"	6.89	7.7	7.34	6.53	11.3	23.3	9.77	8.6	11.2	7.51
Sn	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.06	0.033	0.012	0.028	0.17	0.22	0.013	0.022	0.078	0.015
Ti	"	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
TOC	"	0.7	0.8	0.7	0.8	0.7	0.7	1.2	1.3	0.8	0.6
U	"	0.001	<0.001	<0.001	0.0016	<0.001	0.0012	<0.001	<0.001	0.0012	<0.001
Zn	"	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025

AppendixIII, table 3: Minor and Trace Constituents

		P22D	P22TA	P22TC	P22TD	P23A	P23B	P23TA	P23TB	P23TC	P23TD
Ag	(mg/l)	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Al	(mg/l)	0.0023	0.0247	0.0035	0.0043	0.0038	0.0554	0.0144	0.0187	0.0027	0.0065
As	"	<0.0013	0.0016	0.0017	0.0017	<0.0013	0.0036	0.0025	0.0026	<0.0013	0.0031
B	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	"	0.007	0.054	0.081	0.028	0.049	0.045	0.038	0.056	0.094	0.052
Be	"	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Br	"	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059	<0.059
Cd	"	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Co	"	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	"	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Fe	"	0.0024	2.1	1.5	2.6	0.92	0.3	2.3	1	2	1.5
I	"	0.01	0.018	0.026	0.016	0.013	0.012	0.0096	0.0087	0.0069	0.027
Mn	"	<0.01	0.073	0.042	0.038	0.023	0.019	0.047	0.024	0.053	0.054
Mo	"	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ni	"	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007
P-PO4	"	<0.19	<0.19	<0.19	0.24	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pb	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	"										
Se	"	0.002	0.0035	0.002	<0.0017	<0.0017	0.0038	<0.0017	<0.0017	<0.0017	<0.0017
Si	"	1.6	3.8	4.8	4.8	4.3	4.8	3.4	3.4	3.6	3.6
SiO2	"	3.77	9.28	11.7	11.9	9.28	10.4	7.41	7.46	7.82	8.04
Sn	"	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Sr	"	0.008	0.02	0.04	0.023	0.034	0.079	0.019	0.025	0.053	0.04
Ti	"	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
TOC	"	0.6	0.6	0.5	0.8	0.7	0.7	0.7	0.5	0.5	1.3
U	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	"	<0.025	0.078	0.028	<0.025						

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