**Interpretation of Geological Correlation Borings 1, 2, 3 in the A/M
Area of the Savannah River Site, South Carolina**

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**Upper Three Runs Watershed
A/M Area Advanced Geological Study
Part 2 of 3**

**Interpretation of Geological Correlation
Borings 1, 2, 3 in the A/M Area
of the Savannah River Site, South Carolina (U)**

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Upper Three Runs Watershed
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Part 1 of 3

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The A/M Area Advanced Geological Study is comprised of three separate reports, Parts 1 through 3. The parts are:

Part 1

Investigation on the Combined Use of Ground Penetrating Radar, Cone Penetrometer and High Resolution Seismic Data for Near Surface and Vadose Zone Characterization in the A/M Area of the Savannah River Site, South Carolina (U)

Part 2

Interpretation of Geological Correlation Borings 1, 2, 3 in the A/M Area of the Savannah River Site, South Carolina (U)

Part 3

Geological Interpretation of the Structure and Stratigraphy of the A/M Area, Savannah River Site, South Carolina (U)

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EXECUTIVE SUMMARY

The Geophysical Correlation Boring (GCB) Program was organized to provide a comprehensive correlation capability between geological core and advanced borehole geophysical data, surface high resolution reflection seismic information and, when available, borehole geochemical and cone penetrometer data. This report provides results and initial geological interpretations of borings one, two and three (GCB-1, GCB-2, GCB-3) located within the Upper Three Runs Watershed (A/M Area) of the Savannah River Site.

The interpretation of the GCB borings is guided by the need to establish relationships between core and geophysically derived data. Additionally, the correlation between the geophysical log interpretation and surface derived seismic data is important to understanding the overall A/M, and SRS, geological setting. The GCB-1,2,3 interpretation is presented in a unit by unit correlation comparing core geology and geophysical log derived depositional signatures.

The interpretation of the lithostratigraphy of GCB-1,2,3 suggests that GCB-3 contains sediments that were generally deposited in a more near-shore, subtidal to fluvial, updip environment than sediments in GCB-1 or 2. GCB-1 contains lithologies that are deeper water, subtidal to deltaic while GCB-2 has similar sediments that were deposited in a slightly shallower environment. The present relationship between GCB-1,2,3 indicates that GCB-2 is structurally lower relative to GCB-1 and 3. Correlation of strata between the borings suggests that basement structural events continued through the Paleocene and are terminated by the Lang Syne/Sawdust Landing unconformity. Thickening of sediments within the structurally low depression of GCB-2 after the Lang Syne/Sawdust Landing unconformity suggests a structural reactivation during the Eocene.

In general, GCB-1 and 2 contain intervals with sufficient amounts of clay or fine grained silty material to provide localized confining units throughout the stratigraphic column. GCB-3 contains only minimal clay amounts in thin intervals with minimal confining capability in the Paleocene and Eocene, while thicker clays, with large amounts of silt, are present in the Cretaceous.

The analysis of laboratory core, field core and geophysical log derived data in the GCB borings provides a powerful tool for a comprehensive geological analysis of the subsurface of the Upper Three Runs Watershed. Environments of deposition, structural and stratigraphic correlation and aquifer characteristics may be derived from a combination of these data, leading to a more powerful predictive tool for groundwater flow in support of remedial efforts.

INTRODUCTION

The Geophysical Correlation Boring (GCB) Program was organized to provide a comprehensive correlation capability between geological core and advanced borehole geophysical data, surface high resolution reflection seismic information and, when available, borehole geochemical and cone penetrometer data. Borings were planned in strategic locations within the Upper Three Runs Watershed (A/M Area). All boring locations were chosen to maximize correlation to existing or newly acquired borehole and seismic data and to compliment existing or ongoing environmental programs. This report provides results and initial interpretations of borings one, two and three (GCB-1, GCB-2, GCB-3) located within the A/M Area (Figure 1).

The Geophysical Correlation Boring Program was a joint effort supported by several organizations and agencies. Funding for the program was provided through the WSRC Environmental Restoration Department and administered by WSRC Site Geotechnical Services. Drilling and field oversight were provided by the US Geological Survey through an inter-agency agreement administered through the DOE-SRS Environmental Division. All field work was coordinated through WSRC Site Geotechnical Services and the USGS provided field core descriptions. Additional subcontract services were provided as follows: drilling by EM&TC, Inc., binocular core descriptions by Science Applications International Corporation, field support and coordination by Bechtel Savannah River, Inc., and the Raytheon Corporation. Core geochemical sampling was provided by Microseeps, Inc. Core from the upper 150 feet (50 m) of each boring was split and sent to Rutgers University for detailed soils and transport analysis as part of the DOE-HQ Consortium for Risk Evaluation with Stakeholder Participation (CRESP) program. Borehole geophysical data were acquired by Schlumberger Wireline Services, Inc., and Western-Atlas Wireline, Inc. Additional well logging was provided by Graves Logging Services. Downhole acoustic suspension logging was acquired in GCB-1 and GCB-2 by Agbabian and Associates. Surface seismic information was obtained and processed by the Earth Sciences and Resources Institute of the University of South Carolina. Palynology data and additional core analysis was provided by the Department of Geological Science of Clemson University. Ground Penetrating Radar data for the GCB program was acquired and processed by Microseeps, Inc. All data analysis, interpretation and correlation was provided by WSRC, Site Geotechnical Services.

From this data, lithostratigraphic and hydrostratigraphic interpretations and relationships may be evaluated. This report provides a description of environments of deposition, sedimentary relationships and hydrostratigraphic character for the sediments associated with borings GCB-1, 2 and 3 as correlated on Figure 2.

Figure 1. Location of the Geophysical Correlation Borings, GCB-1, 2, 3 within the Savannah River Site on the South Carolina upper coastal plain.

FIELD ACTIVITIES

The following field activities are described individually by boring.

GCB-1

The GCB-1 boring was spudded, as GCB-1A, on July 19, 1996 by EM&TC. Coring resumed on July 22 and continued through July 28 to a depth of 327 ft (99.6 m). Western Atlas acquired geophysical logs to a depth of 327 feet (99.6 m). Coring resumed on August 1 and continued to August 7, terminating at 500 feet (152 m). Graves Wireline acquired geophysical logs on the upper 500 feet. No casing was required in this boring. Coring resumed on August 25 and continued until September 3 to a depth of 802.7 feet (244.6 m). Schlumberger Wireline Services acquired a full suite of geophysical logs to the total depth of the boring. Agbabian and Associates obtained a suspension log to the total depth of the boring. Core was recovered and described in the field by USGS-Water Resources Division Geologist Kevin Conlan. Drilling fluid halogenated gas samples were acquired periodically through the upper 150 feet (45 m) to evaluate whether Investigation Derived Wastes (IDW) concerns were required. Soil geochemical plugs were obtained approximately every five to 10 feet, if the interval was a sand zone, and analyzed for halogenated solvents. These data are reported in Appendix D. Selected intervals of the remaining core were split and provided to Clemson University for a detailed stratigraphic and palynological analysis. Geophysical logs obtained are listed in Table 1. A detailed foot by foot core analysis was completed by SAIC and is shown in the lithology column of Figure 3. Detailed field descriptions are reported in Appendix A.

GCB-2

The GCB-2 boring was spudded on June 4, 1996 and cored continuously through June 11 to a depth of 492 feet (150 m). Casing was set in the upper 140 feet (42.6 m) because of soft hole conditions and lost circulation. Coring resumed on June 20 and drilled continuously, except for bit and shoe problems, until June 29 at a total depth of 684 feet (208.5 m). Core was recovered and described in the field by USGS-Water Resources Division Geologist Kevin Conlan. Drilling fluid halogenated gas samples were acquired periodically through the upper 150 feet (45.7 m) to evaluate whether IDW concerns were required. Soil geochemical plugs were obtained approximately every five to 10 feet (1.5 to 3 m), if the interval was a sand zone, and analyzed for halogenated solvents. These data are reported in Appendix D. The remaining core was split and provided to Clemson University for a detailed stratigraphic and palynological analysis. The boring was geophysically logged on July 2, 1996 by Schlumberger Wireline Services. Geophysical logs obtained are listed in Table 1. A detailed foot by foot core analysis was completed by SAIC and is shown in the lithology column of Figure 4. Detailed field descriptions are reported in Appendix A.

GCB-3

The GCB-3 boring was spudded on July 1, 1996 and cored continuously through July 2 to a depth of 213 feet (65 m). No casing was required in this boring. Coring resumed on July 11 and continued, except for bit and shoe problems, until July 16 to a depth of 430 feet (131 m), when an injury occurred to a member of the drill crew requiring a stand down until July 20. Coring resumed on July 20 and continued until July 22 to a total depth of 632 feet (192.6 m). At this depth, Western Atlas acquired geophysical logs. Core was recovered and described in the field by USGS-Water Resources Division Geologist Kevin Conlan. Drilling fluid halogenated gas samples were acquired periodically through the upper 150 feet (45.7 m) to evaluate whether IDW concerns were required. Soil geochemical plugs were obtained approximately every five to 10 feet (1.5 to 3 m), if the interval was a sand zone, and analyzed for halogenated solvents. These data are reported in Appendix D. After review, it was decided that the total depth of the boring was not sufficient for acoustical logging to support seismic interpretation and the hole was deepened to 652 feet (198.7 m). Schlumberger Wireline Services acquired sonic and spectral data for the total depth of the boring. Selected intervals of the remaining core were split and provided to Clemson University for a detailed stratigraphic and palynological analysis. Geophysical logs obtained are listed in Table 1. A detailed foot by foot core analysis was completed by SAIC and is shown in the lithology column of Figure 5. Detailed field descriptions are reported in Appendix A.

GCB-1	GCB-2	GCB-3
Digital Sonic	Digital Sonic	Digital Sonic
Formation Micro-Imager	Natural Gamma Spect.	Natural Gamma Spect.
Natural Gamma Spect.	Density/Porosity	Density/Porosity
Density/Porosity	Neutron/Porosity	Neutron/Porosity
Neutron/Porosity	Dual Induction Focused	Dual Induction Focused
Array Induction	Caliper	Caliper
Mag. Resonance		Mag. Resonance
Caliper		

Table 1. Geophysical logs obtained from the GCB borings. The utility of each log is discussed in the Summary section.

INTERPRETATION

The interpretation of the GCB borings is guided by the need to establish relationships between core derived and geophysically derived geology. Additionally, the correlation between the geophysical log interpretation and

surface derived seismic data is important to understanding the overall A/M, and SRS, geological setting. The GCB-1,2,3 interpretation will be presented as a unit by unit correlation comparing core geology and log derived depositional signatures. The stratigraphic unit name is followed by the referenced horizon name for Figures 2 through 5. Hydrostratigraphic nomenclature follows that of Aadland et al. (1995). Stratigraphic nomenclature and environmental comparisons are from Fallaw and Price (1995) and Reineck and Singh (1980). Log interpretations follow suggestions from Schlumberger (1989) and Serra (1985). Table 2 compares basic geophysically derived physical parameters for the units.

Saprolite and Basement (Pzm/Sap and Acoustic Basement)

Crystalline basement lithologies are similar across the GCB-1,2,3 area. In GCB-1, an olive to gray/green weathered chlorite schist overlies a highly fractured bluish gray gneiss. The thickness of the schist is approximately 47 feet (14.3 m) and a distinct contact is present between the schist and gneiss. In GCB-2 and 3, only the chlorite schist interval was sampled which had a similar appearance to the schist of GCB-1. Fractures within the schist of GCB-1 have an approximate northwest strike orientation with a dip varying between 13 and 27 degrees. Fractures and quartz veins within the gneiss appear to have a northeast strike orientation and gentle dips, however, only the upper few feet of the gneiss were sampled for dip information. No oriented dip or strike information is available for GCB-2 and 3. All of the crystalline basement lithologies encountered in GCB-1,2 and 3 were expected as referenced in Cumbest and Price (1989).

The top of basement contact is the first contact with the highly weathered and fractured saprolite. Generally, the saprolite increases in thickness from GCB-2 and 3 to GCB-1 from approximately 13 feet (4 m) in GCB-3 and 15 feet in GCB-2 to approximately 32 feet (9.8 m) in GCB-1. The character of the saprolite varies in each boring. In GCB-1 the saprolite contact is defined by a sharp change between a well indurated sandy/silty clay to gray-green clay with numerous iron oxide stains. The color varies from gray-green to brown-red. In GCB-2 the saprolite is a brown to red mottled clay grading into a dense, massively foliated olive green clay while in GCB-3 the saprolite is a bluish gray to off white, well indurated clay.

Cape Fear Formation (Top CF)

The Cape Fear Formation generally thickens towards the southeast from GCB-3 to GCB-1. The overall lithology of the formation consists of interbedded gravel, sands and clays of varying colors and sizes. Rock fragments and angular sands suggest that the Cape Fear Formation was deposited near its source. There are generally three member sequences, alternating coarsening and fining upwards, that define the formation and that are most developed in GCB-1. The overall

Figure 2. GCB-1, 2 and 3 correlation panel. Datum is set to 330' (110 m) msl. Depths are in feet. Color of correlation lines correspond to color of horizon name. "Top WH" is the top of the Warley Hill Formation. "GCCZ" is the Green Clay Confining Zone. "Top LS/SL" is the top of the Lang Syne/Sawdust Landing Formations. "CBCU" is the Crouch Branch Confining Unit. "Top BC" is the top of the Black Creek Formation. "MqBCU" is the McQueen Branch Confining Unit. "Top Mid" is the top of the Middendorf Formation. "Top CF" is the top of the Cape Fear Formation. "Pzm/Sap" is the contact with the weathered basement rocks or saprolite. Acoustic Basement is the velocity crossover from coastal plain seismic velocities to those more typical of crystalline rocks.

GCB-1

Figure 3. Combined interpretation of GCB-1. Principal geophysical curves are shown. Stratigraphic picks are from the correlation of GCB-1,2 and 3 to regional horizons. Depositional environments are interpreted from the geophysical log signatures, field core descriptions and core laboratory data and are relevant for this figure and Figures 3 and 4. Hydrostratigraphy is from Aadland et al., (1995). Stratigraphy and chronostratigraphy are from Aadland et al. (1995), Fallaw and Price, (1995) and DNAG, 1983.

Figure 4. Stratigraphic correlation plot for GCB-2. Refer to Figure 3 for corresponding hydrostratigraphy, chronostratigraphy and depositional environments.

GCB-3

Figure 5. Stratigraphic correlation plot for GCB-3. Refer to Figure 3 for corresponding hydrostratigraphy, chronostratigraphy and depositional environments.

geophysical log pattern of the sequences, which matches the field core descriptions, suggests that each unit within the formation is a lag channel, shoaling deposit fill with pebbles and heavy sands grading into finer sands with interspersed clays. This interpretation is consistent with the description in Aadland et al., (1995) and Fallaw and Price, (1995).

Within the Cape Fear and at the basal Middendorf, rock resistivity values and deep versus shallow curve separation (an indicator of relative permeability) decrease rapidly. The overall neutron porosity drops from an average of approximately 35% to approximately 20%. The low relative permeability and porosity suggests tighter formations. The lower resistivity values are associated with higher concentrations of heavy minerals and interstitial waters are more mineralized than shallower aquifers. Overall, the Cape Fear and saprolite are indurated with lower permeability, forming the Appleton Confining Unit.

Middendorf Formation (Top Mid)

The Middendorf Formation gradually thickens towards the southeast from GCB-3 to GCB-1. There are correlatable packages of sediments across the formation but it is difficult to correlate specific sand or clay units across the area defined by GCB-1, 2 and 3. Channel and sheet type sands are interbedded with indurated clays suggesting a lower delta plain depositional environment. Many of the sand units in GCB-1,2,3 appear to alternate between fining and coarsening upwards suggesting that they are marine influenced channels or bars. Spectral gamma data, when combined with field core descriptions and lab core analysis, suggests that there are few clays of significant thickness within the formation. Generally, the clays are thin and less than one meter thick. Numerous heavy minerals and micas, as well as fine grained sands with clay balls, generate a spiked appearance of the gamma curve which may be interpreted as numerous interspersed clays. Focused or Induction Resistivity data suggests that there are numerous high permeability zones separated by numerous 'tight' streaks of clay or silt to silty-sand. These zones also suggest that there are non-correlatable sand bodies within the formation with variable permeability, therefore, tracking groundwater movement within the Middendorf within the A/M Area would be extremely difficult.

Black Creek Formation (Top BC)

The Black Creek Formation in borings GCB-1,2,3 may be described in terms of an upper and lower member, possibly two sequences, separated by the McQueen Branch Confining Unit (MqBCU) regional aquitard. Both upper and lower zones have geophysical log and core characteristics that define them as primary regional aquifers.

The lower zone lies unconformably over the Middendorf Formation and consists of interbedded thin clays and sands occurring, more or less, randomly distributed and uniformly spaced throughout the interval. Spectral gamma peak to peak correlation, indicating regional clay units, are possible to track across the borings. These clays are probably localized maximum flooding surfaces, while the basal clays, similar across the area, were deposited in a near shore marine environment. The interbedded sands and clays, often with interspersed iron staining and heavy minerals, is suggestive of a fluvial to upper delta depositional environment.

The MqBCU is a sequence of three principal clays and silty clays occurring in a 40 foot (12.2 m) interval separated by clayey to silty sands. Each of the three units is approximately 10 to 15 feet (3.0 to 4.6 m) thick with the lower unit having the most consistent clay content and thickness. Many of the sands within the MqBCU are moderately sorted and sub-angular with a consistent presence of micas suggesting that these sands are fluvial and deposited near their source. The clays also consistently have micas presence, suggesting that the clays and the sands are both fluvial deltaic to near shore sub-tidal.

The upper zone of the Black Creek is variable across the region of the GCB borings. In GCB-2, the interval consists principally of interbedded clays and sands in beds averaging 5 to 7 feet (1.7 to 2.1 m) thick. This 'serrated' depositional style is common along the margins of bar-finger sands (Busch and Link, 1985). In GCB-1 and 3, the dominant lithology in the upper zone is sand with thin interspersed silt and clay intervals. The sands are dominantly moderately to well sorted, tan to cream in color, and sub-angular to sub-rounded. Micas are present and sometimes abundant with rare heavy minerals. The sand is 75 feet (22.9 m) thick in GCB-3 and 37 feet (11.4 m) thick in GCB-1. These sands are not massive but consist of stacked bar finger, bar-axis and barrier sequences with dips (in GCB-1) of 2° to 12° to the northwest in the upper units, to 14° to 21° to the south-southwest in the middle sands followed by 15° to 29° dips to the northeast in the lower sand units. The average dip direction is to the south. The alternating dip directions are indicative of near shore influence and the measured dips are probably alternating barrier or dune foreset beds.

Samples for palynological analysis were obtained from the GCB-1 boring in a dark, organic rich clay from a depth of 439.5 feet (134 m) at the base of the upper sand unit and top of the MqBCU. Palynomorphs were present indicating a late Campanian to early Maestrichtian age. The spores, pollen, plant cuticle, wood fibers and inertinite, plus a lack of marine algae, indicates that this interval is non-marine (Christopher, personnel communication, 1996).

Steel Creek Formation (Base of CBCU to Top BC)

The Steel Creek Formation is defined from the base of the Crouch Branch Confining Unit (CBCU) to the top of the Black Creek Formation. Dominant lithologies consist of micaceous clays interbedded with sands, sands and silty sands interbedded with thin clays and pebble zones. Micas, including angular grains, are present throughout the interval and iron staining is common. In the basal 50 feet (15.2 m) of each boring, clay content increases and alternates with fine grained silty sands. The overall dip direction is generally random. Sands appear to be more prevalent in the upper portions of the Steel Creek and exhibit morphologies similar to distributary barrier and bar sequences. In GCB-1, these sands generally fine upwards, and exhibit varying dip angles from up to 20° northwest to 12° southeast and 18° northeast. The 'C' sand of Aadland et al., (1995) is present in all wells and gradually varies from a coarsening upwards distributary bar finger and delta lobe sands (Busch and Link, 1985) in GCB-1 and 2 to a more marginal bar finger sand or delta lobe in GCB-3. The remaining sands in the upper portion of the Steel Creek are depositionally similar to the 'C' sand but tend to be more tidal in GCB-3. In general, the sands of the Steel Creek appear to be more landward in GCB-3 and more seaward in GCB-1. It is possible that the Cretaceous/Tertiary boundary (K/T), and contact with the Paleocene, is present at the basal contact of the clay unit immediately overlying the 'C' sand. The presence of pebble lag layers and heavy minerals may define this time sequence marker.

Crouch Branch Confining Unit (Top CBCU to Base CBCU)

The Crouch Branch Confining Unit varies in thickness and clay content from approximately 17 feet (5.2 m) of thin and sparse clays in GCB-3 to 44 feet (13.4 m) of thick silts and clays in GCB-2 to 50 feet (15.2 m) of silty clays and clays in GCB-1. The clays tend to be a white to light gray, plastic kaolinite with thinly laminated purple mineral horizons. The CBCU in GCB-1 is predominantly kaolinitic clay with only minor interspersed laminae of silty clay. In GCB-2, thin lamina of heavy minerals and silts are interspersed within the clays. Thin sands within the unit often have heavy minerals and abundant micas. Thin zones of cemented iron laminae are also present. In GCB-3, only thin clay units are present interspersed with silty clays, sandy silts and sands. Numerous lamina with iron staining and heavy minerals are present. The thin sands tend to grade into pebbles and clay balls. The thin clays, clay balls and shoaling sands units in GCB-3 suggest that GCB-3 CBCU sediments were deposited in a fairly high energy, near shore, possibly intertidal zone, transitioning into a subtidal to delta distributary depositional environment in GCB-1.

This unit, which consists of parts of various formations, forms the principal confining unit across the SRS; therefore is discussed in detail as it controls downward contaminant movement. Permeability variations in the CBCU,

determined from magnetic resonance geophysical logs, are observable in GCB-1. The interval from 240 feet (73.2 m) to 250 feet (76.2 m) is a well indurated and mottled clay. Permeability average less than 200 millidarcies. From 240 feet (73.2 m) to 265 feet (80.8 m), subsurface, the measured permeabilities increase to greater than 1 darcy. All clay within this interval is well indurated and without other noticeable features. Various color changes, suggesting changes in the geochemical makeup of the clays, form numerous lamina throughout the section. The magnetic resonance tool is probably imaging the horizontal permeability associated with these lamina. In the base of the CBCU, from approximately 265 feet (80.8 m) to the top of the Steel Creek Formation at 290 feet (88.4 m) subsurface, the permeability decreases from approximately 500 millidarcies to zero. This interval is also a well indurated clay with fewer lamina, grading into a silty, micaceous clay. At 290 feet (88.4 m) subsurface, the magnetic resonance permeability increase dramatically in the sands of the Steel Creek Formation.

Lang Syne/Sawdust Landing Members (Top LS/SL to Top CBCU)

The Lang Syne and Sawdust Landing Formations (refer to Aadland et al., 1995 and Fallaw and Price, 1995 for nomenclature discussions) are not lithologically differentiated within the A/M Area of the Savannah River Site. Within the area of GCB-1,2,3, these formations vary in thickness between 28 feet (8.5 m) in GCB-3 to 46 feet (14 m) in GCB-2 and 12 feet (3.6 m) in GCB-1. Two distinct, lithologically different and correlatable, members are seen in each boring. The basal member of the Lang Syne/Sawdust landing is a lower bar to delta sheet sand that thins downdip to the southeast. The upper member is a silty clay to clay coarsening upwards into a delta front sheet sand that has the greatest thickness in GCB-2. The silty-sand interval in the upper member in GCB-1 appears to be the distal edge of the delta front. Overall, the general dip of the LS/SL sediments is south-southeast. The sand interval in the upper member appears to be a bar sand that is probably regressive, intertidal and defines the Lang Syne/Sawdust Landing regional unconformity.

The lower 10 feet (3 m) (230 feet (70.1 m) to 240 feet (73.2 m) subsurface) of the LS/SL has an average permeability that exceeds 1 darcy. This interval is a well indurated clay with iron oxide staining and containing some pyrite. The measured permeability in this interval is probably due to microfracturing and the horizontal character of the iron oxide lamina. This interval is capped by a low permeability (less than 10 millidarcies) thinly bedded clay and silty clay. Overlying this clay, is a zone that transitions into a high permeability (greater than 1 darcy) that probably corresponds with the Lang Syne/Sawdust Landing unconformity. In GCB-1, the combination of the underlying CBCU and the high permeability associated with the LS/SL unconformity create the zone with the highest TCE concentrations. The ability to track and map the Lang

Syne/Sawdust Landing Formations and the unconformity zone suggests a way to possibly track halogenated solvents.

Congaree Formation (Top Congaree)

Unconformably overlying the Lang Syne/Sawdust Landing Formations are the assemblages of Early Eocene sediments that comprise the Fourmile Formation. It is lithologically difficult to distinguish these specific formations from the overlying lower middle Eocene Congaree Formation and the entire interval is generally referred to as the Congaree Formation (Aadland et al., 1995). Generally, the lower sands within the interval, when present, are considered equivalent to the Fourmile Formation while the upper sands, when present, are a portion of the Congaree Formation.

Generally, the depositional character of the Congaree in GCB-1,2,3 is similar. There is a slight increase in formation thickness from GCB-3 towards GCB-1 and 2 suggesting a seaward dip. The lithology of GCB-2 and 3 consists of sands, medium to coarse grained, interspersed with thin indurated clays. GCB-2 is dominantly sands with thin silts and a few clay lamina and GCB-3 is dominantly sand with thin clay and iron stained lamina. In GCB-1, there are lithified sand intervals 1.2 to 1.6 inches (30 to 40 mm) thick and siliceous sandstones up to 2 inches (50 mm) thick. Well indurated clays are present as a central unit within the formation and are approximately 10 to 15 feet (3 to 4.6 m) thick associated with silty clays and clayey silts.

Permeability zones are variable within the Congaree. In GCB-1, generally, within the formation, cleaner sand zones have higher permeability, approaching 500 millidarcies, and silty to clayey sands have permeability less than 5 millidarcies. Traces of PCE and TCE are generally seen in the thin sands that are immediately above the well indurated clays.

A shallow shelf to shoreline environments of deposition for the Congaree is evidenced by the dip directions in GCB-1. Basal Congaree sands (possible Fourmile or Fishburne Formation equivalents) generally rotate from a low angle south-southwest dip through a westward to north-northwest dip direction with an angle of 6° to 8° to a low angle northeasterly dip. The upper sand unit (probable Congaree Formation equivalent) has very high, up to 24° dips generally striking to the northeast. The upper sand interval is most indicative of a possible dune sand with the high angle dips suggesting foreset bedding. The basal sands are most indicative of deltaic to near shore barriers and bars.

Warley Hill Formation (Top WH)

The Warley Hill Formation is present in GCB-1, 2 and 3. In GCB-3, the formation is generally geophysically indistinguishable from the over and underlying units,

however, a subdued gamma pattern is similar to the patterns from GCB-1 and 2. In GCB-1, the Warley Hill consists of a sand with interspersed iron oxide modules overlying a silty sand to thinly laminated silty clay. The silty clay, and to some extent the silty sand, form the Gordon Confining Unit with measured log permeability of less than 50 millidarcies. Sands within the upper portion of the formation generally have permeability on the order of 100 to 200 md. In GCB-1, the dip directions within the Warley Hill are varied.

In GCB-2, the Warley Hill sediment character is similar to GCB-1 but the formation is locally exposed on the surface and has been affected by near surface processes. In GCB-3, the formation is generally sandier than GCB-1, and lacks the thin clay lamina and silty sands that constitute the confining unit.

Santee, Tobacco Road/Dry Branch, Upland Formations (Undifferentiated)

The Santee, Tobacco Road/Dry Branch, and Upland Formations are present only in GCB-1. The Santee consists of alternating thin units grading from pebbles and coarse grained sands upward to fine grained sands, all sub-angular to sub-rounded. Heavy minerals are interspersed throughout the units and sparse thinly laminated clays are present. The sands vary in grading from poorly sorted to moderately well sorted. Generally the dip direction of Santee sediments are randomly distributed. A near shore, fluvial to upper deltaic, possibly supratidal depositional environment is indicated by the sediment character. The upper interval of the Santee are generally accepted as forming the regional Santee unconformity of Aadland et al., (1995) and Fallaw and Price, (1995).

The Tobacco Road and Dry Branch Formations immediately overlie the Santee Formation. Both formations are principally sands and silty sands of similar size and grading distributions varying principally in color. The Tobacco Road Formation contains thin clay and silty clay intervals, principally in the base, with interspersed, thinly laminated silty sands. Heavy minerals are generally present.

The Dry Branch Formation consists principally of sands with thinly laminated clayey sands and iron oxide staining. Two intervals are distinct within the formation, an upper, poorly sorted, sub-angular to sub-rounded medium to coarse grained sand with abundant heavy minerals and a lower finer grained sand with thin clay lamina. The lower unit is indicative of fluvial channel to upper deltaic environment and the upper unit is more indicative of a distributary bar to shoreface environment.

The entire Dry Branch Formation is more permeable than the underlying Santee. The basal interval of the upper Dry Branch unit demonstrates measured permeability from 100 to 400 md while the basal unit of the lower unit,

<u>Boring/Strata</u>	<u>GCB-1</u>	<u>GCB-2</u>	<u>GCB-3</u>
<u>Upland</u>			
Depth Interval, ft (m)	32-48 (9.5 -14.6)	not present, eroded	not present, eroded
Density, g/cc	1.91 (0.01)		
Density Porosity, %	44.47 (0.85)		
Neutron Porosity, %	no data		
Photo Electric Value	2.31 (0.01)		
Resistivity, ohm/m	531 (8)		
Permeability, md	45 (3)		
<u>TR/DB</u>			
Depth Interval, ft (m)	48-83 (14.6-25.3)	not present, eroded	not present, eroded
Density, g/cc	1.94 (0.006)		
Density Porosity, %	42.68 (0.36)		
Neutron Porosity, %	no data		
Photo Electric Value	2.9 (0.02)		
Resistivity, ohm/m	543 (5)		
Permeability, md	187 (10)		
<u>Santee</u>			
Depth Interval, ft (m)	83-111 (25.3-34)	not present, eroded	not present, eroded
Density, g/cc	1.92 (0.02)		
Density Porosity, %	43.77 (1.68)		
Neutron Porosity, %	33.29 (2.27)		
Photo Electric Value	2.18 (0.06)		
Resistivity, ohm/m	352 (12)		
Permeability, md	40 (2)		
<u>WH to GCCZ</u>			
Depth Interval, ft (m)	111-123 (34-37.5)	behind pipe	surface horizon
Density, g/cc	1.97 (0.008)	no data	
Density Porosity, %	40.78 (0.5)		
Neutron Porosity, %	41.34 (0.89)		
Photo Electric Value	1.80 (0.04)		
Resistivity, ohm/m	708(104)		
Permeability, md	88 (5)		
<u>GCCZ</u>			
Depth Interval, ft (m)	123-133 (37.5-40.5)	behind pipe	35-47 (10.6-14.3)
Density, g/cc	1.99 (0.009)	no data	1.87 (0.13)
Density Porosity, %	39.92 (0.56)		37.56 (0.77)
Neutron Porosity, %	45.94 (1.0)		47.56 (0.46)
Photo Electric Value	2.31 (0.06)		1.40 (0.04)
Resistivity, ohm/m	177 (18)		145 (5)
Permeability, md	27 (3.1)		110 (9)

Table 2. Summary of sediment parameters derived from geophysical logs presented by stratigraphic unit. Geophysically derived values are followed by the standard deviation in parenthesis. Measured parameters and units are presented in the left hand column. "No data" means the interval was not geophysically logged because the formation was behind casing or too shallow for the logging tool length.

Boring/Strata	GCB-1	GCB-2	GCB-3
Steed Pond Aquifer			
Depth Interval, ft (m)	133-220 (40.5-67.3)	behind pipe	47-139 (14.3-42)
Density, g/cc	1.95 (0.01)	no data	2.1 (0.004)
Density Porosity, %	42.36 (0.73)		38.7 (0.26)
Neutron Porosity, %	43.2 (0.71)		38.8 (0.27)
Photo Electric Value	1.74 (0.01)		1.38 (0.006)
Resistivity, ohm/m	429 (35)		275 (3)
Permeability, md	273 (20)		127 (12)
LS/SL			
Depth Interval, ft (m)	220-251 (67-76.5)	behind pipe	139-153 (42.4-46.4)
Density, g/cc	2.07 (0.01)	no data	2.1 (0.005)
Density Porosity, %	34.9 (0.87)		41.23 (0.44)
Neutron Porosity, %	47.91 (1.88)		40.17 (0.32)
Photo Electric Value	1.93 (0.5)		1.37 (0.01)
Resistivity, ohm/m	474 (42)		43 (1)
Permeability, md	1608 (273)		871 (58)
CBCU			
Depth Interval, ft (m)	251-290 (76.5-88.4)	152-190 (46.3-57.9)	153-169 (46.4-51.5)
Density, g/cc	2.05 (0.004)	2.05 (0.004)	2.6 (0.06)
Density Porosity, %	36.37 (0.27)	36.0 (0.26)	35.88 (0.26)
Neutron Porosity, %	57.47 (0.51)	59.87 (0.61)	44.2 (0.64)
Photo Electric Value	2.5 (0.004)	1.97 (0.02)	1.57 (0.02)
Resistivity, ohm/m	211 (6)	379 (46)	250 (5)
Permeability, md	462 (44)	no data	231 (48)
Steel Creek			
Depth Interval, ft (m)	290-395 (88.5-120.4)	190-271 (57.9-82.6)	169-234 (51.5-71.3)
Density, g/cc	2.07 (0.003)	2.02 (0.009)	2.1 (0.001)
Density Porosity, %	34.7 (0.19)	37.84 (0.56)	40.1 (0.24)
Neutron Porosity, %	43.5 (0.47)	46.25 (0.77)	42.96 (0.31)
Photo Electric Value	1.78 (0.007)	1.57 (0.01)	1.36 (0.005)
Resistivity, ohm/m	1078 (32)	1224 (50)	339 (22)
Permeability, md	8865 (1295)	no data	814 (36)
BC to MqBCU			
Depth Interval, ft (m)	395-432 (120.4-131.7)	271-390 (82.6-118.9)	234-317 (71.3-96.6)
Density, g/cc	2.12 (0.002)	2.04 (0.0)	1.97 (0.002)
Density Porosity, %	32.2 (0.14)	36.77 (0.23)	47.3 (0.4)
Neutron Porosity, %	38.81 (0.29)	42.84 (0.20)	44.48 (0.14)
Photo Electric Value	1.75 (0.009)	1.56 (0.005)	1.23 (0.009)
Resistivity, ohm/m	1184 (48)	1416 (43)	266 (1)
Permeability, md	no data	no data	1441 (63)

Table 2 continued.

Boring/Strata	GCB-1	GCB-2	GCB-3
MqBCU			
Depth Interval, ft (m)	432-476 (131.7-145.1)	390-429 (118.9-130.8)	317-352 (96.6-107.3)
Density, g/cc	2.11 (0.005)	2.08 (0.008)	no data
Density Porosity, %	32.56 (0.35)	34.40 (0.48)	no data
Neutron Porosity, %	47.6 (0.84)	51.47 (0.87)	no data
Photo Electric Value	2.11 (0.005)	1.72 (0.02)	no data
Resistivity, ohm/m	786.7 (64)	908 (69)	no data
Permeability, md	no data	no data	2048 (219)
MqBCU to Mid.			
Depth Interval, ft (m)	476-582 (145.1-177.4)	429-515 (130.8-157)	352-472 (107.3-143.9)
Density, g/cc	2.13 (0.004)	2.08 (0.006)	no data
Density Porosity, %	31.56 (0.28)	34.2 (0.39)	no data
Neutron Porosity, %	39.7 (0.29)	42.91 (0.24)	no data
Photo Electric Value	1.76 (0.01)	1.6 (0.01)	no data
Resistivity, ohm/m	1083 (33)	1350 (44)	no data
Permeability, md	no data	no data	820 (74)
Mid to CF			
Depth Interval, ft (m)	582-696 (177.4-212.1)	515-626 (157-190.8)	472-597 (143.9-182)
Density, g/cc	2.13 (0.004)	2.13 (0.006)	no data
Density Porosity, %	31.1 (0.26)	31.38 (0.37)	no data
Neutron Porosity, %	34.92 (0.22)	36.79 (0.30)	no data
Photo Electric Value	1.72 (0.006)	1.63 (0.008)	no data
Resistivity, ohm/m	1141 (32)	901 (48)	no data
Permeability, md	no data	no data	154 (10)
Cape Fear			
Depth Interval, ft (m)	696-728 (212.1-221.9)	626-650 (190.8-198.1)	597-618 (182-188.4)
Density, g/cc	2.22 (0.01)	2.19 (0.01)	no data
Density Porosity, %	25.94 (0.69)	27.44 (0.61)	no data
Neutron Porosity, %	40.69 (0.94)	38.45 (0.13)	no data
Photo Electric Value	2.14 (0.04)	1.99 (0.04)	no data
Resistivity, ohm/m	74.94 (8.15)	80 (8)	no data
Permeability, md	no data	no data	7 (2)
Saprolite			
Depth Interval, ft (m)	728-757 (221.9-230.7)	650-665 (198.1-202.7)	618-631 (188.4-192.3)
Density, g/cc	2.16 (0.02)	2.2 (0.02)	no data
Density Porosity, %	29.55 (1.55)	38.19 (0.16)	no data
Neutron Porosity, %	44.59 (1.39)	53.26 (0.10)	no data
Photo Electric Value	2.94 (0.04)	2.74 (0.09)	no data
Resistivity, ohm/m	7.88 (0.69)	7 (0.3)	no data
Permeability, md	no data	no data	no data
Crystalline			
Depth Interval, ft (m)	757-774 (230.7-235.9)	666-676 (202.7-206)	631-722 (192.3-220.1)
Density, g/cc	2.51 (0.005)	2.50 (0.01)	no data
Density Porosity, %	8.42 (0.35)	8.82 (1.06)	no data
Neutron Porosity, %	23.57 (0.68)	38.8 (1.4)	no data
Photo Electric Value	3.1 (0.02)	3.98 (0.14)	no data
Resistivity, ohm/m	14.41 (0.24)	9.9 (0.04)	no data
Permeability, md	no data	no data	no data
Total Depth, ft (m)	802 (244.4)	684 (208.5)	722 (220.1)

Table 2 continued.

immediately overlying the Santee unconformity, has log derived permeability approaching 600 md.

The Upland Formation is present on the surface to a depth of approximately 17 feet (5.2 m) in GCB-1. The formation is similar to the underlying Tobacco Road and consists of moderately to well sorted, sub-angular to sub-rounded sands and silty sands with interspersed thin clay lamina. The well sorted sands are immediately overlying the Tobacco Road Formation and form a fining upwards fluvial channel with abundant heavy minerals and micas. Shallower sediments of the Upland have been affected by near surface processes.

HYDROGEOLOGIC RELATIONSHIPS

Table 2 provides a unit to unit comparison of basic hydrogeological parameters such as permeability and porosity. In general, GCB-1 and 2 contain intervals with sufficient amounts of clay or fine grained silty material to provide localized confining units. GCB-3 contains only minimal clay amounts in thin intervals with minimal confining capability. The relative amounts of sand in each location is shown on a sand-mud (clay)-gravel ternary diagram in Figure 6. For GCB-1, in blue, there are dominant sands intervals but also dominant mud (clay) zones. GCB-2, in red, is dominantly sand but with a higher fraction of clay and fewer distinct clays. Clays, and gravels, in GCB-3, in green, are more dispersed with minimal to no distinct clays. Most confining units in GCB-3 are silty clays to clayey silts. Gravels are more prominent and persistent in GCB-3 supporting the updip environment of deposition interpretation for this boring. Based on the ternary relationships of Figure 6, GCB-1 is depositionally more downdip or seaward than GCB-2, and both are depositionally more marine than GCB-3.

Figures 7 and 8 are z-plots of GCB-1 and 3 respectively. These figures plot the gamma values versus the percent clays (muds) versus the deep induction resistivity. GCB-1 is representative of GCB-2 (refer to ternary distribution on Figure 6) so only GCB-1 is plotted and only the upper aquifers are shown for GCB-3. This combination of data provides a graphical display of aquifers (relatively clean sands with freshwater resistivity) versus confining units (high mud content intervals with lower mineral resistivity), both in depth. Highlighted areas on the graph are presented relative to depth and gamma signature to indicate confining zones. Relative confining unit (or conversely, an aquifer unit) location and thickness may be inferred from these data. Competent confining units are seen in GCB-1 (and therefore for GCB-2) and thin, minimal confining zones are seen in GCB-3. As noted on Figure 6, the confining units defined by the z-plot for GCB-3 contain higher amounts of silty material than do the confining units in GCB-1.

Figure 6. Ternary diagram of sand, mud and gravel distribution in GCB-1,2,3. GCB-1 is in blue, GCB-2 in red and GCB-3 in green. GCB-1 has dominant sand lithologies (large clusters of blue near the sand node) with lessor dominant but distinct mud (clay) facies (cluster of blue near mud node). GCB-2 is predominantly sand but is more dispersed towards the mud and gravel nodes than GCB-1. GCB-3 is also dominantly sand but is also more dispersed towards the gravel node with only a minor mud (clay) component. Data were derived from core lab analysis.

Figure 7. Z-plot of GCB-1 using deep induction resistivity, percent mud (clay) and the calculated gamma ray response. The area outlined in purple reflects relatively low resistivity, moderate gamma counts and high percentages of mud, all indicators of potential confining units. The purple zones on the geophysical log plot to the right correspond to values outlined on the graph and indicate potential depths and stratigraphic locations of confining units.

Figure 8. Z-plot of GCB-3 using deep induction resistivity, percent mud (clay) and the calculated gamma ray response. The area outlined in purple reflects relatively low resistivity, moderate gamma counts and high percentages of mud, all indicators of potential confining units similar to GCB-1 in Figure 7 with corresponding locations of confining units on the log plot. The area outlined in orange corresponds to low gamma, low mud and similar resistivity which defines possible aquifers. The yellow zones are clean sands and may represent major aquifer units while the green zone is intermediate between aquifer and aquitard. This figure strongly suggests that GCB-3 has fewer confining zones than GCB-1 and historically has sediments deposited in a more updip environment.

SUMMARY

The interpretation of the lithostratigraphy of GCB-1,2,3 suggests that GCB-3 contains sediments that were generally deposited in a more near-shore, subtidal to fluvial, updip environment than sediments in GCB-1 or 2. GCB-1 contains lithologies that are deeper water, subtidal to deltaic while GCB-2 has similar sediments that were deposited in a slightly shallower environment. The present relationship between GCB-1,2,3 indicates that GCB-2 is structurally lower relative to GCB-1 and 3. Correlation of strata between the borings suggests that basement structural events continued through the Paleocene and are terminated by the Lang Syne/Sawdust Landing unconformity. Thickening of sediments within the structurally low depression of GCB-2 after the Lang Syne/Sawdust Landing unconformity suggest structural reactivation during the Eocene.

In general, GCB-1 and 2 contain intervals with sufficient amounts of clay or fine grained silty material to provide localized confining units throughout the stratigraphic column. GCB-3 contains only minimal clay amounts in thin intervals with minimal confining capability in Paleocene and Eocene formations, while thicker clays, with larger amounts of silt, are present in the Cretaceous age materials.

The use of advanced geophysical logging has proven highly successful in the GCB borings. Multi-spectral gamma ray measurements allowed for the delineation of clays versus naturally radioactive sands providing a more precise aquitard definition. Sand units with similar spectral signatures were correlated with more confidence. The use of multiple porosity tools such as the density and neutron porosity provided aquifer and confining unit porosity based on differing physical measurements. The density utilizes bulk volume of sediments while the neutron utilizes fluid content. The comparison of the measured porosity from these tools allow for a confident porosity value to be determined. Focused induction resistivity logs provided a detailed definition of vertical variations in resistivity associated with hydrogeological units. Zones of greater or lessor fluid movement could be determined as well as the influence of heavy minerals. The highly advanced magnetic resonance logging provided for a precise measurement of in-situ permeability and defined zones of greater or lessor flow potential. The borehole sonic data provided a distinct correlation between surface reflection seismic data and lithostratigraphic response. The use of these logs combined allowed for a more precise definition lithostratigraphy and hydrostratigraphy and for the interpretation of depositional setting.

The analysis of laboratory core, field core and geophysical log derived data in the GCB borings provides a powerful tool for a comprehensive geological analysis of subsurface of the Upper Three Runs Watershed. Environments of deposition, structural and stratigraphic correlation and aquifer characteristics may be derived from a combination of these data, leading to a more powerful predictive tool of groundwater flow supporting remedial efforts.

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WSRC-RP-97-0185

Revision 0

June, 1997

Appendix A

USGS Field Core Descriptions for GCB-1, 2, 3

WSRC-RP-97-0185

Revision 0

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Core Hole: # GCB-1

8-25-96

Recovered:

Run 1	500-503	2.3'	500-502.3
Run 2	503-505	1.5	503-504.5
Run 3	505-512	5.6	505-510.6
Run 4	512-517	1.7	512-513.7
Run 5	517-520	1.1	517-518.1
Run 6	520-525	4.6	520-524.6
Run 7	525-528	1.9	525-526.9
Run 8	528-533	2.9	528-530.9

8-26-96

Run 9	533-536.2	2.7	533-535.7
Run 10	536.2-540	1.2	536.2-537.4
Run 11	540-540.5	100%	
Run 12	540.5-544	2.7	540.5-543.2
Run 13	544-547	100%	
Run 14	547-552	4.7	547-551.7
Run 15	552-557	4.1	552-556.1
Run 16	557-560.5	2.3	557-559.3
Run 17	560.5-562	no recovery	
Run 18	562-564	1.7	562-563.7
Run 19	564-566.3	1.8	564-565.8
Run 20	566.3-569	2.6	566.3-568.9
Run 21	569-572.5	100%	
Run 22	572.5-574	100%	
Run 23	574-578	100%	
Run 24	578-582	3.3	578-581.3
Run 25	582-585	2	582-584
Run 26	585-592	6.9	585-591.9
Run 27	592-596	3.6	592-595.6
Run 28	596-599.5	2.6	596-598.6
Run 29	599.5-600	no recovery	
Run 30	600-606	no recovery	
Run 31	606-607	no recovery	

8-27-96

Run 32	607-609	1.1	607-608.1
Run 33	609-612	2.2	609-611.2
Run 34	612-616	3.6	612-615.6
Run 35	616-620	3	616-619
Run 36	620-620.5	100%	
Run 37	620.5-627	3.2	620.5-623.7

Recovered:

Run 38	627-632	2.7	627-629.7
Run 39	632-633.5	1	632-633
Run 40	633.5-636	1.4	633.5-634.9
Run 41	636-639	2.9	636-638.9
Run 42	639-644	4.1	639-643.1
Run 43	644-647	2.1	644-646.1
Run 44	647-650	2.3	647-649.3
Run 45	650-653	2.4	650-652.4
Run 46	653-656	.5	653-653.5
Run 47	656-660	3	656-659
Run 48	660-666	3.1	660-663.1

8-28-96

Run 49	666-670	2.4	666-668.4
Run 50	670-673	1.8	670-671.8
Run 51	673-678	2.8	673-675.8
Run 52	678-679	.8	678-688.8
Run 53	679-680	100%	
Run 54	680-682	1.8	680-681.8
Run 55	682-683	.6	682-682.6
Run 56	683-686	100%	
Run 57	686-687	no recovery	
Run 58	687-689.5	2.3	687-689.3
Run 59	689.5-689.8	no recovery	
Run 60	689.8-692	1.3	689.8-691.1
Run 61	692-695	2.9	692-694.9
Run 62	695-698	100%	
Run 63	698-700	100%	
Run 64	700-706	3.7	700-703.7

8-29-96

Run 65	706-708.5	2.4	706-708.4
Run 66	708.5-712	3.4	708.5-711.9
Run 67	712-713	.8	712-712.8
Run 68	713-715	1.5	713.5-715
Run 69	715-716	100%	
Run 70	716-718	100%	
Run 71	718-722	100%	
Run 72	722-723	100%	
Run 73	723-727	3.9	723-726.9
Run 74	727-731	100%	
Run 75	731-736	100%	
Run 76	736-742.4	100%	
Run 77	742.4-743	100%	

Recovered:

Run 78	743-745	100%	
Run 79	745-747.5	100%	
Run 80	747.5-752	4.3	747.5-751.8

8-31-96

Run 81	752-757	4.8	752-756.8
Run 82	757-761	100%	
Run 83	761-762	100%	
Run 84	762-762.3	100%	
Run 85	762.3-766.3	100%	
Run 86	766.3-769.3	100%	
Run 87	769.3-771.5	100%	
Run 88	771.5-774	100%	

9-1-96

Run 89	774-781	100%	
Run 90	781-785.8	100%	
Run 91	785.8-787.4	100%	

9-2-96

Run 92	787.4-791	100%	
Run 93	791-799	100%	
Run 94	799-802.3		

9-3-96

Run 95	802.3-802.7		
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Total: 79% recovered

FIELD GEOLOGIC LOG

PROJECT		DATE		SHEET 1 OF 1	
REFERENCE DATA		DRLING CONTRACTOR		USGS - WRP	
WELL NO.		DRAFTER		LOGGED BY	
6C13-1H		Todd Hunter		Kevin J Conlon	
SAP COORDINATES		DRLING METHOD		COMPANY	
		Wire line core		USGS - WRP	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRLING COMMENTS
10-13	10				
11	11			Sand, m. to c. (1000 to 1400) well sorted, med. to c. brown (10R 4/6) to dk. red brown (10R 2/4), subang. iron oxide staining.	
12	12				
13	13			dk. pale purple (5Y 6/3)	
14	14			Sand, m. to c. (350 to 1400) well sorted, med. to c. brown (10R 4/6) to dk. red brown (10R 2/4), subang. iron oxide staining.	
15	15				
16	16				
17	17			Sand, m. to c. (850 to 1700) well sorted, med. to c. brown (10R 4/6) to pale red purple (5Y 6/3), subang. iron oxide staining.	
18	18				
19	19				
20	20				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 2 OF
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#4 20-25	20				
	21			Sand, fluvial (177 to 5000) well sorted, mortled, dk. brown (10YR 6/4), med. (5R 4/6), gray to purple (5R 4/2), any to silty, mica abundant, clay (20%)	
	22				
	23		22.5		
	24				
#5 25-27	25			Sand, fluvial (177 to 3500, 14100) moderately sorted, mortled, med. light gray (10YR 6/4), dk. gray (10YR 6/2), med. (5R 4/6), any to silty, mica plentiful, moderate, clay (15%)	
	26			alternating laminae = 2 to 5 mm thick of clayey sand & sand, diff. colors	
#6 27-32	27		24.7		
	28			clayey sand, fluvial (177 to 20000) poorly sorted, mortled, med. light gray (10YR 6/4), dk. gray (10YR 6/2), med. (5R 4/6), pale red (5R 4/6), silty, mica common, clay (30%)	
	29			alternating thin laminae = 2 to 10 mm thick of diff. colors	
	30				
	31				
#7 32-37	32		31.9		
	33			clayey sand, fluvial (177 to 10000, 20000) poorly sorted, mortled as above, silty, clay (30 to 40%) sharp contact w	
	34			Sand, fluvial (125 to 2500) well sorted, dk. brown (10YR 6/4), any to silty, clay (2-5%), numerous thin laminae = 2 to 4 mm thick of sand & clay, fluvial (177 to 5000) well sorted, off-white, silty, clay (10-20%)	
	35				
	36		30.1		
#8 37-42	37				
	38			Sand, fluvial (177 to 5000) well sorted, dk. gray (10YR 6/4), silty, clay (5 to 10%)	
	39			numerous thin laminae = 2 to 4 mm thick of clean sand & clayey sand, as described above	
	40				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 3 of
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#9 42-47	40			Sand, as described on sheet 2	
	41	X			
	42	X			
	43	X			
#10 47-52	44	X		1) silty clay, dk gray (10YR 4/6), poorly indurated	
	45	X			
	46	X		2) Sand, fl. to m. (125 to 350 ϕ) well sorted, dk gray (10YR 4/6), arg. dk minerals common, clay (5%) numerous thin laminae = 2 to 4 mm thick, of clean sand + clayey sand,	
	47	X			
#11 52-57	48	X		3) sand, m. to c. (250 to 1000 ϕ) moderately well sorted, dk gray (10YR 4/6), subang to submed, dk minerals common, clay (2 to 5%) numerous thin laminae = 2 to 4 mm thick of clean sand + clayey sand, med red (5R 4/6) to up to org (10YR 7/2) grades into:	
	49	X			
	50	X		4) numerous thin laminae = 2 to 4 mm thick, of iron oxide staining, gray to purple (5R 4/2)	
	51	X		5) clayey sand, fl. to m. (175 to 350 ϕ) well sorted; dk gray (10YR 4/6), arg. to subang med indurated	
#12 57-62	52	X			
	53	X		Sand, m. to c. (350 to 1410 ϕ) poorly to med sorted, dk gray (10YR 4/6) subang to submed dk minerals: plentiful to abundant, clay (22%) numerous thin laminae = 2 to 4 mm thick, starting @ 54', of clean sand to clayey sand, up to org (10YR 7/2)	
	54	X			
	55	X			
#12 57-62	56	X			
	57	X		Sand, m. to c. (250 to 1410 to 2000 ϕ) poorly sorted, dk gray (10YR 4/6) subang to submed dk minerals: plentiful to abundant	
	58	X			
	59	X			
#12 57-62	60	X			

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 4/ OF
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#13 62-65	60				
	61				
	62			Sand, ml to ucl (250 to 1410 or 2000 or) same as above	
#14 65-67	63				
	64				
	65		64.7		
#15 67-72	66		100%	Sand, ml to ucl (350 to 1410 or 2000 or) mod sorted, dk yw org (10YR 5/6), subang to submed, sh minerals: plentiful, grades into numerous thin laminae ≈ 2 to 4 mm thick, of clayey sand up to org (10YR 8/2) iron oxide staining from 66.2 to 66.8, mod rd (5R 4/6)	
	67				
	68				
#16 72-77	69			Sand, ml to ucl (250 to 2000 or) poorly sorted, dk yw org (10YR 5/6), subang to submed sh minerals: plentiful, mica inv to common numerous thin laminae ≈ 2 to 4 mm thick, of clayey sand, off white (10YR 8/2) to off white	
	70				
	71				
#17 77-82	72		71.4		
	73		100%	Sand, ml to ucl (250 to 1410 or 2000 or) poorly to mod sorted, dk yw org (10YR 5/6), subang, sh minerals: plentiful numerous thin laminae ≈ 2 to 4 mm thick, of clayey sand, off white (10YR 8/2)	
	74				
#18 77-82	75				
	76				
	77			1) Sand, ml to ucl (350 to 1000 or) mod to well sorted, dk yw org (10YR 5/6), subang to submed, sh minerals: common, clay (5%) grades into:	
#19 77-82	78		2)	2) Sand, ml to ucl (250 to 1000 or 1410 or) mod to well sorted, dk yw org (10YR 5/6), subang to submed sh minerals: common, clay (5%)	
	79		3)	3) Sand, ml to ucl (250 to 1000 or) well sorted, dk yw org (10YR 5/6), subang to submed, clay (5%) numerous thin laminae ≈ 2 to 4 mm thick, of clayey sand, off white (10YR 8/2)	
	80				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 5 of
WELL NO. GC13-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#18 82-87	80				
	81				
	82				
#19 87-90	83			Sand, microvel (350 to 1000) well sorted, dk yw org (10YR 6/6) subang to submed, dk minerals: common clay (2/9)	
	84			numerous thin laminae = 2 to 3 mm thick, of clayey sand, off white (10Y)	
	85				
	86				
	87				
#20 90-92	88			Sand, micro vel (350 to 8000) pebbles (5% 2 to 4 mm thick) mod sorted, dk yw org (10YR 6/6) subang to submed, dk minerals: rare, clay (5 to 7%) streaks of mod rd brown (10R 4/6)	
	89				
	90				
#21 92-97	91		100%	1) Sand, micro vel (850 to 1410) pebbles (5 to 10% 2 to 5 mm thick) partly to mod sorted, dk yw org (10YR 6/6) mod rd (5R 4/6) to mod yw brown (10YR 5/4) subang to submed, clay (3 to 5%) alternation thin laminae = 2 to 5 mm thick of sand clayey sand & clay grades in r.o.	
	92			2) Sand, micro vel (177 to 7100, 2000) mod sorted, dk yw org (10YR 6/6) submed to subang, dk minerals: rare, clay (2%)	
	93			3) Sand, micro vel (350 to 2000) pebbles (5% c 94.6' 2 to 5 mm thick) mod sorted, mod yw brown (10YR 5/6) dk yw org (10YR 6/6) subang, clay (2%) thin laminae = 4 mm thick of qtz pebbles (3 to 5 mm thick) from 94.6' to 95'	
	94			grades in r.o.	
	95			4) Sand, micro vel (350 to 1410) pebbles (10 to 5% 2 to 5 mm thick) mod sorted, mod rd brown (10R 4/6) subang to submed, dk minerals: rare to common, clay (10%)	
#22 97-102	96				
	97			Sand, fine med (177 to 500 to 1410) pebbles (15 to 20% 2 to 7 mm thick) mod sorted, mod rd brown (10R 4/6) subang to submed, clay (2%)	
	98			From 97 to 97.8 numerous thin laminae = 2 mm thick of clay, off white (10Y)	
	99			color change c 98.7' mod rd (5R 4/6) to v dk rd (5R 3/6)	
	100				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 6 of
WELL NO. GC13-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#23 102-107	100			as described above	
	101				
	102		101.8'	pebbles (2 to 5%, 2 to 5 mm thick)	
	103		1)	1) Sand, ml to ucl (250 to 1000 or 2000+) mod to well sorted, dk yw org (10YR 5/6), ang to subang, dh minerals: rare grades into:	
	104				
#24 107-112	105		2)	2) Sand, ml to ucl (250 to 2000+) pebbles (10%, 2 to 7 mm thick) poorly to mod sorted, dk yw org (10YR 5/6) mod yw brown (10YR 5/4), subang to submod, mica: common clay (5 to 10%)	
	106		105.7'	alternating laminae = 2 to 10 mm thick, of clean sand, clayey sand, clay-off white (U) & pebble sand	
	107		100%	3) Sand, silty, fl to fcl (125 to 250+) well sorted, light brown (5YR 5/6) to dk yw org (10YR 5/6) ang to subang, dh minerals: common clay (2% to 5%), mica: rare	
	108			numerous thin laminae = 2 to 3 mm thick of clean sand, up to org (10YR 5/6) to off white (U)	
	109		3)	some are sand lithified especially c = 110.8'	
#25 112-117	110			4) clayey sand, fl to fcl (125 to 250+) well sorted, mod brown (5YR 4/4) to mod yw brown (10YR 5/4) ang clay (10 to 15%) mica: common	
	111		4)	4) lithified fine (argill) sand = 30 mm thick. 5) interbedded sand (clean), ml to ucl (350 to 1410+) pebbles (2 to 4%, 2 to 5 mm thick) poorly to mod sorted, pale yw org (10YR 7/2), ang to subang, clay (2 to 5%)	
	112		5)	5) Sand, ml to ucl (500 to 1410+) pebbles (2%, 2 to 4 mm thick) mod sorted, dk yw org (10YR 5/6) ang to subang, dh minerals: rare to common	
	113				
	114			No Recovery	
#26 117-122	115				
	116				
	117		100%		
	118			Sand, ml to ucl (250 to 1410 or 2000+) mod sorted, light brown (5YR 5/6) to dk yw org (10YR 5/6), ang to subang, mica: rare	
	119			black iron oxide cemented aggregates = 3 to 10 mm thick, black (U)	
	120				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 7 of
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. GCLB-1A		DRILLER	
LOGGED BY		DRILLING METHOD	
SRP COORDINATES		COMPANY	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	120			as describe on sheet 6 sharp contact w below	
#27 122- 127	121		1)	1) Sand, mlt to vch (350 to 2000 v) mod sorted, mod yw (5YR 7/6), subang to subround, mica: common To rare	
	122		100%	2) Sand, silty, fl to mh (125 to 350 v) well sorted, light brown (5YR 5/6) to dk yw org (10YR 4/6), ang to subang	
	123			from 122 to 123.5 numerous thin laminae = 2 to 3 mm thick of clean sand, off white (W9), pale grn yw (10Y 7/2), mica: rare, dh minerals: rare, clay (2%)	
	124		2)	3) silty clay, or clayey silt, well indurated, grn org (10YR 7/4), slightly lithified, large flake	
	125		3)	sand - sugary	
	126		4)	4) Sand, mlt to vch (250 to 1410 v) mod sorted, light brown (5YR 5/6) to dk yw org (10YR 4/6), ang to subang, dh minerals: rare to common	
#28 127- 132	127		100%		
	128			Sand, mlt to vch (250 to 2000 v) poorly sorted, dk yw org (10YR 4/6), ang to subang, dh minerals: common grades into:	
	129			1% increase in amount of pebbles (3 to 10 mm thick) subang to subround	
	130			= 130' silty sand, fl to fu (125 to 250 v, 1000 v - 2000 v) mod to well sorted, dk yw org (10YR 4/6), 5 to 7% ang to subang, mica: rare, dh minerals: rare, clay (2%)	
	131			change in color, texture (lith), @ 131' light brown (5YR 5/6)	
#29 132- 137	132			5) Sand, mlt to vch (250 to 1410 v) mod sorted, dk yw org (10YR 4/6), subang to subround, dh minerals: common grades into:	
	133		5)	= 134' silty sand, fl to mh (125 to 350 v) well sorted, dk yw org (10YR 4/6), ang to subang clay (2 to 4%) sharp contact w below:	
	134			pebbles (20, 2 to 5 mm thick)	
	135				
#30 31 137- 142	136		6)	6) Sand, mlt to vch (250 to 2000 v), poorly sorted, uple org (10YR 7/2), w. grn org (10YR 7/4), subang dh minerals: common clay (5 to 7%)	
	137		136.8'	numerous thin laminae = 2 mm thick, or iron oxide staining, dk yw org (10YR 4/6)	
	138			Sand, mlt to vch (250 to 1000 v) mod sorted, dk yw org (10YR 4/6) to pale yw org (10YR 6/6), ang to subang, clay (2 to 4%) grades into:	
	139				
	140				

come
back
*
TO

PROJECT	DATE	SHEET	OF
REFERENCE DATUM	DRAWING CONTRACTOR		
SAP COORDINATES	DRAWER		
LOGGED BY	COMPANY	DRAWING METHOD	

[illegible]

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 9 of
WELL NO. GCB-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#39 162- 167	160			as described on sheet 9	
	161		160.4		
	162		0	1) Sandstone, lithified sand, fhr fll (125 to 250 ϕ) well sorted, upale org (10YR 8/2) to	
	163		2)	gry org (10YR 7/4), mica: common, dh minerals: common	
	164		1)	2) clay, well indurated, pale yw brown (10YR 6/2) w some thin sand laminae $\approx$ 102 mm thick	
#40 167- 172	165		3)	fhr fll (125 to 250 ϕ)	
	166		3)	3) Sandstone, lithified sand, $\approx$ 30 mm thick, in contact w sand, fhr fll (177 to 500 ϕ) well sorted	
	167		2)	any no subang	
	168			clay, well indurated, pale yw brown (10YR 6/2)	
	169				
#41 172- 177	170			c 170.5' lithified sand (sandstone) $\approx$ 25 mm thick, light brown (5YR 5/6) to dk yw org (10YR 6/4)	
	171		171.2		
	172		3)	4) clay, yw gry (5Y 7/2), well indurated	
	173		5)	* $\approx$ 60 mm thick zone of lithified clay	
	174		4)	5) sand, mbrck (250 to 710 ϕ) well sorted, gry org (10YR 7/4), any no subang	
#43 177- 182	175			some lithified sand (sandstone) present	
	176				
	177		177.2	6) Siliceous sand (sandstone) $\approx$ 50 mm thick, light gry (10YR 7/2) in contact w:	
	178			7) Sand, mt to alk (250 to 1000 ϕ) well sorted, gry org (10YR 7/4), subang no submnd,	
	179			dh minerals: common, mica: rare to common	
	180				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 10 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. GC13-1A	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#44 182- 187	180				
	181				
	182				
	183			clay, well indurated, from 182 to 183' yw gry (5Y 7/2)	
	184			from 183 to 184' olive gry (5Y 7/1)	
	185			from 184' to 186' yw gry (5Y 7/2)	
#45 187- 192	186				
	187		186.1		
	188		2)	1) clay, well indurated, yw gry (5Y 7/2)	
	189		2)	* iron oxide amt E base of clay $\approx$ 2mm thick, drk yw gry (10YR 6/4) to light brown (5YR 5/6)	
	190		2)	2) Sand, fU to mU (197 to 500 ϕ) well sorted, drk yw gry (10YR 6/4), ang to subang	
	191			dhminerals: common to plentiful	
#46 192- 197	191			when sand is in contact w clay there is iron oxide staining light brown (5YR 5/6) to med brown (5YR 4/4)	
	192		3)	3) Sand, mU to ck (250 to 710 ϕ , 1410 ϕ) well sorted, light brown (5YR 5/6) to drk yw gry (10YR 6/4),	
	193		4)	ang to subang, mica: rare to common, dhminerals: rare	
	194		5)	three clay laminae $\approx$ 5, 10 & 15 mm thick, yw gry (5Y 7/1), located $\approx$ 192.5, 192.7, 192.8	
	195			iron oxide amt laminae located above & below clay laminae $\approx$ 2mm thick, drk rd brown (10R 3/4)	
	196		6)	4) sand, fU to mU (125 to 350 ϕ , 1000 ϕ) well sorted, v. lustrous rd (10R 3/4), subang, dhminerals: common	
#47 197- 202	197			5) clay, well indurated, pale yw gry (10YR 8/6) to pale yw brown (10YR 6/2)	
	198			6) Sand, mU to ck (350 to 1000 ϕ), well sorted, gry gry (10YR 7/4), subang to submed,	
	199			dhminerals: common to plentiful	
	200		196.2		
	201			Sand, mU to ck (250 to 1000 ϕ) med to well sorted, gry gry (10YR 7/4) ang to subang, dhminerals: plentiful	
	202			numerous clay stringers $\approx$ 1mm thick, off white w/rd	
				* iron oxide amt laminae $\approx$ 2mm thick, drk rd brown (10R 3/4)	
				numerous thin clay laminae $\approx$ 2 to 4mm thick, off white w/rd from 198.4 to 199'	
				clay ball present 5 to 10mm diameter	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET // of
WELL NO. 6CB-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#48 202- 207	200			as described on sheet 10	
	201				
	202		100%		
	203			Sand, micro vel (350 to 1410) mod sorted, gry org (10YR 7/4) to dk yw org (10YR 6/6)	
#49 50 207- 212	204			subang to submed, dhminerals: common to plentiful	
	205			numerous clay stringers, off white (W)	
	206				
	207				
#51 212- 217	208			1) Sand, micro vel (350 to 2000) poorly to mod sorted, gry org (10YR 7/4) to dk yw org (10YR 6/6), subang to submed, dhminerals: common	
	209			numerous clay stringers, off white (W) $\approx$ 2 mm thick, numerous clay balls $\approx$ 2 to 4 mm in diameter	
	210			2) Sand, micro vel (350 to 1000 to 1410) mod sorted, light brown (5YR 5/6) to dk yw org (10YR 6/6), subang to submed, dhminerals: common to plentiful	
	211			numerous clay stringers, off white (W) $\approx$ 2 mm thick	
#52 217- 222	212				
	213			3) Sand, fluo vel (177 to 500) well sorted, dk yw org (10YR 6/6) to light brown (5YR 5/6) ang to subang, mica: common to plentiful, grades into: numerous clay stringers $\approx$ 2 to 4 mm thick, off white (W)	
	214				
	215			4) Sand, fluo vel (177 to 2000) granules (5% 2 to 4 mm thick) poorly sorted, gry org (10YR 7/4) to dk yw org (10YR 6/6), subang to submed, mica: plentiful, dhminerals: plentiful	
#52 217- 222	216			numerous clay stringers $\approx$ 2 to 4 mm thick, off white (W)	
	217		216.8		
	218			Sand, micro vel (350 to 2000) pebbles (10 to 15% 2 to 12 mm thick) poorly to mod sorted, gry org (10YR 7/4) to dk yw org (10YR 6/6), subang to submed, dhminerals: plentiful	
	219			mica: common	
#52 217- 222	220			* iron oxide staining, rusty red (10R 3/2), $\approx$ 15 mm thick	
				numerous clay stringers $\approx$ 2 to 4 mm thick, off white (W)	
				numerous thin laminae of clay $\approx$ 4 to 10 mm thick, off white (W) to pale gray (10YR 8/6), from 218.6 to 219.4', iron oxide staining above + below clay laminae	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 12 OF
WELL NO. GCB-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#53 222- 227	220			as described on sheet 11.	
	221				
	222		221.6		
	223		1)	1) Sand, micro well (350 to 2000 μ) pebbles (5 to 7%, 2 to 5 mm thick), poorly rounded sorted, arg. org (10YR 7/4) to dk. yw. org (10YR 6/6), subang. al. minerals: plentiful, mica: common	
#54 227- 232	224			numerous clay stringers $\approx$ 2 mm thick, off white (2.9)	
	225			* iron oxide staining $\approx$ 15 mm thick, dusky rd (10R 3/2)	
	226		2)	2) clay, well indurated, yw. arg (5Y 7/2)	
	227		226.7	iron oxide staining of sand in contact w clay, dusky rd (10R 3/2)	
#55+ 56 232- 237	228		3)	3) clay, well indurated, off white (2.9) to pale yw. arg (10YR 8/6)	
	229		4)	iron oxide staining of sand in contact w clay	
	230			4) Sand, micro well (350 to 2000 μ) pebbles (5 to 10%, 2 to 10 mm thick), med sorted, light brown (5YR 5/6) to dk. yw. arg (10YR 6/6), subang. to subrid, al. minerals: common to plentiful, mica: rare	
	231				
#57+ 58 237- 242	232			clay, well indurated, mottled, upale org (10YR 8/2), pale yw. arg (10YR 6/6), light rd (5R 6/6), pale purple (5P 6/2)	
	233			iron oxide smt c base of clay $\approx$ 4 mm thick	
	234				
	235				
#57+ 58 237- 242	236			iron oxide smt (concrete) c top of clay $\approx$ 15 mm thick	
	237			clay, well indurated, mottled, light gr. (10Y) to med bluish gr. (5B 7/1)	
	238			clay, well indurated, mottled, light gr. (10Y) to med bluish gr. (5B 5/1)	
	239			pyrite present	
	240				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 13 of
WELL NO. GC13-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#59 242- 247	240	XXXX			
	241	—		clay, as above, mod indurated	
	242	—	100%		
	243	—			
#60 247- 252	244	—		clay, well indurated, mottled, light gray (N7) w med light gray (N6) w med bluish gray (5B 5/1)	
	245	—			
	246	—			
	247	—	100%		
#61 252- 257	248	—		clay, well indurated, mottled, as described above also dusky rd (5R 3/4) @ 248.2'	
	249	—			
	250	—			
	251	—			
#62 257- 262	252	—			
	253	—		clay, mod indurated, ulight gray (N8)	
	254	—		@ 253.9'	
	255	—		clay, well indurated, mottled, ulight gray (N8) w mod org pink (10R 7/4) w mod red brown (10R 4/6)	
#62 257- 262	256	—			
	257	—			
	258	—		clay, same as above	
	259	—			
	260	—			

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 14 OF
WELL NO. 6C13-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	260	---		as described on sheet 13	
	261	---			
#65 262- 267	262	X			
	263	---		clay, well indurated, mottled, light gray (U8) w mod rd (10R 4/6) w mod rd (5R 5/6)	
	264	---			
	265	---			
#64 267- 272	266	X	265.8		
	267	---			
	268	---		clay, well indurated, mottled, light gray (U8) w mod gw (5Y 7/6) w mod rd (5R 4/6)	
	269	---			
	270	---			
	271	---			
#66 272- 277	272	X			
	273	---			
	274	---		clay, well indurated, mottled, same as above, also mod rd brown (10R 4/6)	
	275	---			
	276	---			
#68 277- 282	277	X			
	278	---		clay, well indurated, mottled, same as above	
	279	---			
	280	---			

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 15 OF
WELL NO. GC13-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	280			as described on sheet 14	
	281				
	282				
	283			1) clay, well indurated, mottled, light gray (N7) to medium (5Y7/6)	
	284			grades into:	
	285				
	286				
	287			2) silty clay, mod indurated, micaceous (very), off light gray (N8)	
	288			chase of clay iron oxide or MnO staining + amt ~ 5 mm thick	
	289			3) silty clay, mod indurated, micaceous, upale gray (10YR 8/2)	
	290			(*) iron oxide staining or MnO staining ~ 20 mm thick	
	291			4) Sand, silty, f. to m. (125 to 350 μ) well sorted, mottled, upale gray (10YR 8/2)	
	292			pale purple (5P 4/2), to gray red purple (SRP 4/2), with light olive brown (5Y 5/6), any, micaceous, thin minerals: common	
	293			5) Sand, m. to vch (250 to 1410 μ) mod sorted, pale red purple (SRP 4/2) any to subang,	
	294			micaceous: abundant, grades into:	
	295			6) Sand, m. to vch (250 to 1410 μ) mod sorted, subang to submed	
	296			5) Sand, as described above	
	297				
	298			6) Sand, m. to vch (250 to 1410 μ) well sorted, off white (N9), any to subang,	
	299			v micaceous, thin minerals: common, clay (2%) clay texture	
	300			(*) iron oxide staining ~ 5 mm thick, some amt, dusky red purple (SRP 3/2)	
				Sand, m. to vch (250 to 1410 μ) mod sorted, off white (N9), any to subang,	
				micaceous, thin minerals: rare to common, clay (2%) clay texture, grades into:	
				(*) numerous thin laminae ~ 2 to 4 mm thick of iron oxide staining or MnO, dusky red purple (SRP 3/2)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 16 OF
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	300		1)	1) as described on sheet 15	
	301		2)	2) Sand, micro vel (350 to 2000 μ) granules (15%, 2 to 4 mm thick) poorly to med sorted, mottled, up to clay (10YR 8/2) to med vel (10R 6/6), w/ off white (w), subang.	
	302		301.5	3) micaceous, dhminerals: plentiful	
	303		2)	2) Sand, as described above	
	304		3)	3) Sand, micro vel (250 to 1410 μ) granules (20.5%, 2 to 4 mm thick), off white (w) to pale gray w (10Y 8/2), ang to subang, micaceous, dhminerals: common to plentiful	
	305		4)	4) Sand, micro vel (250 to 710 μ) pebbles (50%, 2 to 10 mm thick) poorly sorted, off white (w), micaceous, dhminerals: common clay (5 to 10%), subang to submed	
	306		5)	5) Sand, fine to med (177 to 710 μ) well sorted, off white (w), ang, micaceous, dhminerals: rare clay (2%) clay texture	
	307		306.6		
	308		6)	6) Sand, micro vel (250 to 1410 μ) med sorted, off white (w) to pale gray w (10Y 8/2), ang to subang, micaceous, dhminerals: rare to common, clay (4.2%) clay texture	
	309			thin clay laminae $\approx$ 20 mm thick, gray (5Y 8/1)	
	310		7)	7) Sand, fine to vel (177 to 2000 μ) pebbles (10%, 2 to 7 mm thick) poorly sorted, off white (w) to pale gray w (10Y 8/2), subang to submed, dhminerals: plentiful to abundant	
	311			mica: common to plentiful, clay (2%) clay texture	
	312		311.3	clay balls present $\approx$ 2 to 3 mm diameter	
	313		8)	8) Sand, micro vel (350 to 2000 μ) poorly to med sorted, off white (w) to pale gray w (10Y 8/2), subang to submed, micaceous, dhminerals: rare, clay (2%) clay texture	
	314			grades into:	
	315		9)	9) Sand, ch to vel (500 to 2000 μ) pebbles (25%, 2 to 5 mm thick) med sorted, med clay (10R 6/6), subang to submed, dhminerals: rare to common	
	316				
	317				
	318			Sand, micro vel (250 to 1410 μ) med to well sorted, light red (5R 4/6) to med red (10R 4/6), subang to submed, micaceous, dhminerals: plentiful to abundant, clay (2%) grades into:	
	319			alternating laminae (bands) $\approx$ 2 to 4 mm thick of clean sand & clayey sand	
	320			sreak of dhminerals $\approx$ 1 to 2 mm thick	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 17 OF
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#81 320-321	320		1)	1) as described on sheet 16	
	321		2)	2) Sand, mltro vel (250 to 2000 μ) pebbles (40 to 50%, 2 to 7 mm thick) poorly sorted, offwhite (W) to pale gm yw (10YR 7/2), subang to submed, micaceous, dhminerals: plentiful, clay (2-5%)	
	322		3)	3) Sand, mltro vel (250 to 2000 μ) pebbles (30%, 2 to 7 mm thick) poorly sorted	
	323		4)	4) Sand, flt to vel (177 to 1410 μ , 2000 μ) pebbles (10%, 2 to 5 mm thick) poorly to mod sorted, offwhite (W) to pale gm yw (10YR 7/2), subang to submed, micaceous, dhminerals: common, clay (2%) clay texture grades into	
	324				
#82 325-327	325				
	326				
	327		326.6	c 325.8' Sand, flt to vel (177 to 500 μ) well sorted, offwhite (W) and to subang, micaceous, dhminerals: plentiful to abundant, clay (2%) clay texture	
	328		328.2	Sand, mltro vel (350 to 2000 μ) pebbles (10 to 15%, 2 to 5 mm thick), mod sorted, offwhite (W) to pale org (10YR 8/2), subang to submed, micaceous, dhminerals: common, clay (2 to 5%) clay balls present = 2 to 4 mm diameter @	
	329				
#83 332-333	330				
	331				
	332				
	333		5)	5) Sand, mltro vel (350 to 2000 μ) pebbles (10 to 15%, 2 to 5 mm thick) mod sorted, same as above grades into:	
	334				
#85 337-342	335		6)	6) Sand, clt to vel (500 to 2000 μ) pebbles (5 to 10%, 2 to 5 mm thick) mod to well sorted, offwhite (W) to pale org (10YR 8/2), subang to submed, micaceous, dhminerals: common, clay (2%) clay balls present = 4 to 7 mm diameter @ grades into:	
	336				
	337			c 335.5' Sand, mltro vel (350 to 1410 μ) mod to well sorted, offwhite (W) to pale gm yw (10YR 7/2), subang, micaceous, dhminerals: plentiful to abundant, clay (2%) clay texture	
	338		7)	7) Sand, flt to vel (177 to 500 μ) well sorted, offwhite (W) and to subang, micaceous, dhminerals: common, clay (2%) clay texture grades into:	
	339			clayey sand stringers, mod yw (5Y 7/6)	
	340				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 18 of
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. GCB-1A	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#86 342- 247	340		1)	1) as described on sheet 17	
	341		2)	2) Sand, mltro vel (350 to 1410) pebbles (50% 2 to 7mm thick) poorly sorted, off white (Ls) to molyb (5% 7%), subang to ang, micaceous, dhminerals: plentiful to abundant, clay (5 to 7%) clay laminae $\approx$ 2 to 4mm thick	
	342		3)	3) Sand, mltro vel (250 to 2000) pebbles (30 to 40% 3 to 7mm thick) poorly sorted, off white (Ls), subang to subang, micaceous, dhminerals: plentiful, clay (2 to 5%) clay texture	
	343			4) Sand, mltro vel (250 to 2000) poorly to mod sorted, off white (Ls), subang to subang, mica: plentiful, dhminerals: plentiful, clay (2%) clay balls present 10 to 20mm in diameter	
#87 347- 352	344				
	345		5)	5) Sand, mltro vel (350 to 2000) granules (50% 2 to 4mm thick) poorly to mod sorted, off white (Ls), subang to subang, micaceous, dhminerals: common to plentiful, clay (2%) clay texture	
	346			6) iron oxide staining + amt $\approx$ 30mm thick, drk red brown (10R 3/4), limonite present	
	347			6) Sand, mltro vel (350 to 710) well sorted, off white (Ls) to pale gray (10Y 8/6) ang to subang, micaceous, dhminerals: common, clay (2%) clay texture	
#88 352- 357	348		6)		
	349				
	350				
	351		7)	Sand, mltro vel (250 to 500) well sorted, off white (Ls), ang to subang, micaceous, dhminerals: rare to common, clay (2%) clay texture	
#89 357- 359	352			8) iron oxide amt $\approx$ 10mm thick, velvety red (10R 3/2)	
	353				
	354		8)	Sand, mltro vel (250 to 1000) well sorted, off white, ang to subang, micaceous, dhminerals: rare, clay (2%) clay texture grades, nro:	
	355			$\approx$ 358.2' Sand, mltro vel (350 to 2000) mod sorted, off white (Ls), ang to subang, micaceous, dhminerals: rare, clay (2%) clay texture	
	356			Sand, mltro vel (250 to 2000) granules (30% 2 to 4mm thick) poorly to mod sorted, off white (Ls), subang to subang, mica: common to plentiful, dhminerals: abundant, clay (2%) clay laminae $\approx$ 30mm thick,	
#90 359- 362	357		9)		
	358				
#90 359- 362	359		10)		
	360				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 19 OF
WELL NO. GCB-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	360			Sand, as described in sheet 18	
#71 361-367	361				
	362			1) Sand, ml to vcl (250 to 2000 ϕ) granules (30%, 2 to 4 mm thick), off white (10YR 7/2), arg to silty arg, micaceous, dhminerals: rare to common, clay (2%)	
	363		1)	clay balls present $\approx$ 5 mm diameter $\odot$	
	364			2) Sand, ml to vcl (350 to 2000 ϕ) pebbles (30% 4 to 7 mm thick) off white (10YR 7/2), silty to submed, mica: common, dhminerals: plentiful, clay (5 to 10%)	
	365		3)	numerous clay balls present $\approx$ 5 to 15 mm diameter	
	366			3) Sand, ml to vcl (350 to 2000 ϕ) med sorted, drk gray (10YR 4/6) silty to submed, clay (2%), clay ball present $\approx$ 20 mm diameter, off white (10YR 7/2) $\odot$	
#72 367-372	367		4)	4) Sand, ch to vcl (500 to 2000 ϕ) granules (20 to 30%, 2 to 4 mm thick) med sorted, upale org (10YR 8/2) to gray org (10YR 7/4), silty to submed, dhminerals: rare; clay ball present $\approx$ 20 mm diameter $\odot$	
	368		5)	5) iron oxide staining $\approx$ 20 mm thick, med brown (5YR 3/4) limonite / staining, pale yellow (10YR 8/6)	
	369			6) iron oxide staining or MnO ₂ , $\approx$ 20 mm thick, gray rd purple (5YR 4/2)	
	370		5)	5) Clay, med indurated, yellow (5Y 8/1)	
	371				
#73 372-377	372			clay, med to well indurated, pinkish gray (5YR 8/1) to yellow gray (5Y 8/1), micaceous	
	373			grades into:	
	374				
	375			$\approx$ 375' silty clay, med indurated, yellow gray (5Y 8/1), micaceous	
	376				
#74 377-382	377			6) silty sand, fl to med (175 to 500 ϕ) well sorted, off white (10YR 7/2) to pale gray (10YR 8/2), arg, v micaceous, clay (5 to 10%), indurated, clay texture	
	378		6)		
	379			7) iron oxide staining $\approx$ 10 mm thick, rusty rd (10R 3/2)	
	380		7)	7) Sand, ml to vcl (300 to 2000 ϕ) granules (20 to 25%, 2 to 4 mm thick) med sorted, gray org (10YR 7/4), silty to submed, v micaceous, dhminerals: common, clay (2%)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 20 of
WELL NO. 6CB-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
	380			Sand, as described on sheet 19	
	381				
	382				
	383		1)	1) Sand, mkr. vcll (250 to 2000) mod sorted, grey org (10YR 7/4), subang, dhminerals: common mica: common grades into:	
	384			2) iron oxide staining + cmr $\pm$ 35 mm thick, mod brown (5YR 5/4)	
	385		2)	2) Sand, mkr. vcll (350 to 2000) granules + pebbles (40% 2 to 8 mm thick) poorly sorted, grey org (10YR 7/4), subang to subind, micaceous, dhminerals: common to plentiful, clay balls present $\pm$ 30 mm diameter	
	386				
	387				
	388		3)	3) Sand, mkr. vcll (250 to 2000) granules (25 to 30%, 2 to 4 mm thick) poorly sorted, off white (4.5) to pale org (10YR 7/2), subang to subind, mica: common, dhminerals: common to plentiful, clay (5 to 10%), clay ball present $\pm$ 25 mm diameter	
	389		4)	4) iron oxide staining in contact clay below, $\pm$ 30 mm thick, v. dark purple (5R 3/2)	
	390			5) clay, well indurated, yellow (5Y 7/2)	
	391				
	392				
	393		5)	5) clay, well indurated, yellow (5Y 7/2)	
	394		6)	6) iron oxide staining in contact clay above 10 mm thick, v. dark red (5R 3/2)	
	395			7) Sand, mkr. vcll (250 to 2000) mod sorted, off white (4.5) to pale org (10YR 7/2), subang, micaceous, dhminerals: common to plentiful, clay (2 to 5%) grades into:	
	396				
	397				
	398		7)	7) Sand, mkr. vcll (350 to 2000) granules + pebbles (30% 2 to 8 mm thick) poorly sorted, off white (4.5) to pale org (10YR 7/2), subang to subind, micaceous, dhminerals: common, clay (2 to 5%) grades into:	
	399		8)	8) Sand, cl. vcll (200 to 2000) granules (10% 2 to 4 mm thick), off white (4.5), subang to subind micaceous, clay (2 to 5%), clay balls present $\pm$ 5 to 10 mm diameter	
	400				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 21 OF
WELL NO. 6LB-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
	400			sand, as described on sheet 20	
	401				
	402			pebbles (10%, 4 to 5 mm thick)	
	403			Sand, micro vel (350 to 2000 μ) granules (10%, 2 to 4 mm thick) mod sorted, pale org (10% R 1/2) to grey org (10% R 1/4), subang to submed, micaceous, dhminerals: common to plentiful, clay (5 to 7%)	
	404				
	405				
	406				
	407				
	408		1)	1) Sand, micro vel (350 to 2000 μ) granules + pebbles (25 to 30%, 2 to 8 mm thick) poorly to med sorted, pale org (10% R 1/2) to pale grey org (10% R 1/4) subang to submed, mica: common, dhminerals: common, clay (5%)	
	409		2)	2) clay, mod indurated, grey (5% R 1/4), iron oxide staining above & below clay in contact w	
	410		3)	3) Sand, clayey, micro vel (250 to 1000 μ , 2000 μ) well sorted, off white (N4), ang to subang, micaceous, clay (10 to 20%) clay texture clay balls present 320 to 370 mm diameter	
	411				
	412			4) Sand, micro vel (350 to 2000 μ) pebbles (20% 2 to 5 mm thick) poorly to med sorted, off white (N4), subang to submed, mica: plentiful to abundant, dhminerals: common, grades into:	
	413		4)		
	414				
	415			5) Sand & clay, micro vel (250 to 1410 μ) mod sorted, off white (N4), ang to subang, micaceous	
	416		5)		
	417				
	418			Sand, micro vel (710 to 2000 μ) granules (20% 2 to 4 mm thick) subang, off white (N4), micaceous, dhminerals: common, clay balls present	
	419				
	420				

#38
38
39#99
402-
407#100
407-
412#101
412-
417#102
417-
422

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 22 OF
WELL NO. GC13-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	420			Sand, as described on sheet 21	
	421				
#103 422- 427	422			Sand, ml to vel (350 to 2000 w) granules (30 to 40%, 2 to 4 mm thick) pebbles (1% 4 to 7 mm thick) poorly sorted, off white (U1) to upale org (10YR 5/2), avg to subang, mica common to plentiful, dh minerals: common, clay (<1%) grades into:	
	423				
	424			c 423.8' Sand, ml to vel (250 to 2000 w) granules (25%, 2 to 4 mm thick) pebbles (5 to 10% 4 to 7 mm thick) poorly to mod sorted, off white (U1) to upale org (10YR 5/2), subang to submod, micaceous, dh minerals: common, clay (<1%), clay texture, clay balls present $\approx$ 4 mm diameter	
	425				
	426				
#104 427- 432	427			Sand, ml to vel (350 to 2000 w) granules (30% 2 to 4 mm thick) mod sorted, upale org (10YR 5/2) to gray (10YR 4/4), subang to submod, mica: plentiful to abundant, dh minerals: common grades into:	
	428				
	429				
	430			c 430' Sand, el to vel (500 to 2000 w) well sorted, off white (U1), subang to submod, micaceous, dh minerals: rare to common, clay (<2%) clay texture, clay balls present $\approx$ 2 to 5 mm thick	
	431				
#105 432- 437	432			1) Sand, ml to vel (250 to 2000 w) poorly to mod sorted, off white (U1), avg to subang, micaceous, dh minerals: common to plentiful, sharp contact w clay below	
	433		1)		
	434				
	435			1) clay, mottled, dusky rd (5YR 3/4) to dusky rd (10YR 3/2) to dk gray (10YR 4/4) to pale yellow (10YR 5/2) iron oxide staining throughout section	
	436		2)		
	437			3) clay, mottled, pale brown (5YR 5/2) to pale yellow (10YR 6/3) to pale gray (10YR 5/2) sharp contact w below:	
#106 437- 442	438		3)		
	439			4) Rich organic clay, gray black (10YR 2/2) to black (10YR 1/1) sharp contact w clay below	
	440		4)		

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 23 OF
WELL NO. 6CB-1A		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
302 42 302 43	440		2	① iron oxide cmr $\approx$ 5mm thick, mod rd brown (10YR 4/6)	
	441			clay, v micaceous, mottled w v pale org (10YR 7/2) & dk yw org (10YR 6/6)	
	442				
	443		3	clay same as above	
15109 447 452	444		2	② iron oxide cmr & staining, light brown (5YR 5/6) to pale yw org (10YR 6/6)	
	445			③ sand, mbr sh (350 to 710 μ , 410 μ) mod sorted, off white (L5) ang to subang, micaceous, clay (5%) grades into:	
	446			C $\approx$ 443.8' sand, mbr sh (350 to 1000 μ) granules (35% 2 to 4mm thick) mod poorly sorted, clean sand, off white (L5) to v pale org (10YR 7/2), micaceous, dm minerals: common	
	447				
302 43 302 44	448			④ sand, mbr sh (350 to 1000 μ) granules (5 to 10% 2 to 4mm thick) well sorted, v pale org (10YR 7/2) to gray org (10YR 7/4), ang to subang, mica: plentiful, dm minerals: common	
	449				
	450			⑤ iron oxide staining, $\approx$ 10mm thick, dk yw org (10YR 6/6)	
	451		4	⑥ clay, gray org pink (5YR 7/2)	
302 43 302 44	452			clay as above	
	453				
	454				
	455				
302 43 302 44	456			sand w. clay, fbr sh (125 to 350 μ) well sorted, mottled, pale yw org (10YR 7/6) to dk yw org (10YR 6/6)	
	457		2	⑦ iron oxide staining or MnO staining, rusty rd purple (5R 4/2)	
	458				
	459			Sand, mbr sh (350 to 2000 μ) granules (35% 2 to 4mm thick) mod sorted, off white (L5), subang, mica: common, dm minerals: common, clay balls present	
302 43 302 44	460				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 24 of
WELL NO. 6613-1A		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
	460			Sand as described on page 24	
	461				
#112 462-467	462				
	463		1)	1) Sand, dk to v. dk (500 to 2000 ϕ) granules (10 to 15% & to 4mm thick) mod sorted, off white (5R) to v pale org (10YR 8/2), subang to subrnd, mica: common, thin to med: common, sharp contact massive iron oxide staining $\approx$ 20cm thick, v. dk rd (5R 3/6) to v. dk rd (10R 3/2)	w. dk rd
	464		2)	2) clay, mottled, v pale org (10YR 8/2) to mod rd (5R 3/6), well indurated	
	465				
	466				
#113 467-472	467				
	468				
	469			clay, mottled, well indurated, same as above	
	470				
	471				
#114 472-477	472				
	473				
	474			dk, mottled, well indurated, same as above	
	475				
	476				
#115 477-482	477			Sand, dk to v. dk (125 to 350 ϕ) well sorted, v pale org (10YR 8/2), ang to subang, micaceous, thin to med: common, clay (2%) grades into:	
	478				
	479			$\approx$ 478 Sand, m. dk to v. dk (350 to 1410 ϕ , 2000 ϕ) mod sorted, off white (5R) subang to subrnd, micaceous, clay (2.5%) red clay feature	
	480				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 25 of
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. G613-1A	SAP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
5 Box 116 482-487	480			Sand, as described on sheet 24	
	481				
	482				
#117 487-492	483			Sand, med to vel (350 to 2000+) granules & pebbles (20% 2 to 8 mm thick) med sorted, off white (L9), subang to subround, micaceous, sh minerals, clay (2%)	
	484				
	485				
#118 492-497	486				
	487				
	488			Sand, med to vel (350 to 2000+) granules & pebbles (20% 2 to 8 mm thick), as above	
#119 497-500	489				
	490				
	491				
#119 497-500	492			Sand, med to vel (250 to 1000+) well sorted, off white (L9), ang to subang, micaceous, sh minerals: common clay balls present $\approx$ 5 to 10 mm in diameter, clay (2%)	
	493			some granules present (laminae) $\approx$ 5 mm thick (10% 2 to 4 mm thick)	
	494				
#119 497-500	495				
	496				
	497			Sand, fine to med (175 to 200+) well sorted, off white (L9), ang, sh minerals: common some granules (10% or less 2 to 4 mm thick) clay balls present $\approx$ 4 to 10 mm in diameter	
#119 497-500	498				
	499				
	500				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 26 OF
WELL NO. GCB-1		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#1 500-503	500			1) clayey sand, ch rock (500 to 2000+) granules & pebbles (5 to 10% 2 to 8 mm thick), mod (SR 4/6)	
	501			subang, clay (25 to 30%) possible slugs	
	502		502.3	2) Sand, ml rock (350 to 2000+) granules & pebbles (20% 2 to 8 mm thick) mod sorted, grey org (10YR 7/4) subang to subord, clay balls (numerous) present ± 5 to 10 mm in diameter	
#2 503-505	503				
	504		504.5	clay, well indurated, grey org pink (5YR 7/2) to pale yw brown (10YR 4/2)	
#3 505-512	505				
	506				
	507			Sand, ml rock (250 to 110+) well sorted, grey org (10YR 7/4), am to subang, micaceous, dh minerals: rare to common - some clay balls present ± 5 to 10 mm in diameter	
	508				
	509				
	510				
	511		510.6		
#4 512-517	512			3) Sand, ml rock (350 to 1410+) mod sorted, grey org (10YR 7/4), clayey, dh minerals: common, clay balls present ± 5 to 10 mm in diameter	
	513				
	514		513.7	4) clay, well indurated, light grey (6.5)	
	515				
	516				
#5 517-520	517				
	518		517.1	Sand, ch rock (711 to 2000+) granules (10 to 15% 2 to 4 mm thick) mod sorted, off white (8Y) to grey org (10YR 7/4), subang to subord, clay balls present	
	519				
	520				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 27 OF
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#6 520-525	520				
	521			Sand, sh to vck (500 to 2000+) granules (15% 2 to 4 mm thick) gray org (10YR 7/4) subang to subrnd, dhminerals: plentiful, clay balls present ± 5 to 10 mm in diameter.	
	522			numerous laminae = 10 mm thick of pebbles (4 to 8 mm thick) subrnd to rnd	
	523				
	524				
	525		524.6		
#7 525-528	525		1)	1) Sand, sh to vck (500 to 2000+) granules (15% 2 to 4 mm thick) med to well sorted, gray org (10YR 7/4) ang to subang, clay balls present, dhminerals: common	
	526		2)	2) clay, well indurated, gray org pink (5YR 7/2) ± iron oxide omt laminae ± 2.5 mm thick, dusky rd (10R 3/2)	
	527		526.9		
#8 528-533	528		3)	3) clayey sand, ml to rd (250 to 500+, 10+) well sorted, pale org (10YR 6/2), ang, dhminerals: common clay (25%)	
	529		4)	4) Sand, ml to vck (350 to 2000+) well sorted, gray org (10YR 7/4), subang dhminerals: common clay balls present: ±	
	530		530.9		
	531				
	532				
#9 533-536.2	533		5)	5) Sand, sh to vck (710 to 2000+) granules (10 to 15% 2 to 4 mm thick) well sorted, gray org (10YR 7/4), subang to subrnd, clay ball present ± 20 mm in diameter	
	534				
	535			6) pebble sand, (4 to 10 mm thick) well sorted, subrnd to rnd	
	536		535.7		
#10 536.2-540	536		7)	7) pebble sand, same as above	
	537		8)	8) clay, well indurated, pale gray brown (10YR 6/2)	
	538		537.4		
	539				
	540				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 28 OF
WELL NO. GC13-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#11 540-540.5	54.0	---		Silty clay, well indurated, sand < 5%, well (1/10 to 20000), yw grey (5Y 7/2)	
#12 540.5-544	54.1	---			
	54.2	---		Silty clay, well indurated, mottled, yw grey (5Y 7/2) w mod rd (5R 5/4), some calcareous	
	54.3	---			
	54.4	---	543.2		
#13 544-547	54.5	---		Silty clay to clayey sand, mod to well indurated, v pale org (10YR 7/2) w mod rd (5R 5/4) v micaceous	
	54.6	---		grades into #14 546' clayey sand, flinty (125 to 3500) well sorted, mottled, mod pink (5R 7/4) w grey pink (5R 5/2) v pale org (10YR 7/2) ang, v micaceous	
#14 547-552	54.7	---		clay (25 to 20%)	
	54.8	---		Sand, ch to vll (500 to 20000) granules (10% 2 to 4 mm thick) mod sorted, v pale org (10YR 7/2) to mod pink (10R 7/4), ang to subang, micaceous grades into:	
	54.9	---			
	55.0	---		p. 549.5' Sand, ch to vll (500 to 20000) granule + pebbles (25 to 30%, 2 to 8 mm thick) mottled, light rd (5R 6/4) w mod rd org (10R 6/4) w v pale org (10YR 7/2) subang to mod	
	55.1	---			
#15 552-557	55.2	---	551.7		
	55.3	---	1)	1) Sand, ch to vll (500 to 20000) granules (10 to 15% 2 to 4 mm thick) mod to well sorted, grey org (10YR 7/4) to v pale org (10YR 7/2) subang, clay balls present & grades into:	
	55.4	---			
	55.5	---	2)	2) Sand, m to vll (250 to 7100) well sorted, grey org (10YR 7/4) to v pale org (10YR 7/2) ang, micaceous	
	55.6	---	556.1		
#16 557-560.5	55.7	---			
	55.8	---	3)	Sand, m to vll (250 to 7100, 10000) well sorted, off white (10YR 8/2) to v pale org (10YR 7/2)	
	55.9	---		559.3	
	56.0	---		*) iron oxide or MnO2 amt lenticular = 5 mm thick	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 29 OF
WELL NO. GCB-1		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#17 560.5- 562	560				
	561			No Recovery	
#18 562- 564	562				
	563			Sand, mk to vck (250 to 2000+) granules (20% 2 to 4 mm thick) arg org (10YR 7/4), poorly sorted, arg to subarg, dhminerals common, clay balls present ≈ 5 to 10 mm in diameter	
#19 564- 566.3	564		562.7		
	565			Sand, mk to vck (250 to 2000+) same as above, mottled, off white (10Y 8/2) w pale org (10YR 8/2) w med rd (5R 5/4), streaks (lamina) of dhminerals ≈ 2 to 4 mm thick	
#20 566.3- 569	566		565.8		
	567		1)	Sand, flinty (125 to 500+) well sorted, gray to pink (10R 8/2) to pale org (10YR 8/2), arg, micaceous grades into 1	
	568		2)	* iron oxide or MnO amt ≈ 5 mm thick	
	569		100%	* clay, well indurated, mottled, gray (5Y 7/2) w pale rd purple (5R 6/2)	
#21 569- 572.5	569			* iron oxide or MnO amt ≈ 20 mm thick	
	570				
	571			Sandy clay, well indurated, mottled, pinkish gray (5YR 8/1) w pale rd purple (5R 6/2)	
	572			sand, ch to vck (500 to 2000+) subarg to submed	
#22 572.5- 574	573		100%		
	574			Sandy clay, well indurated, same as above	
#23 574- 578	575		100%		
	576			Sandy clay, well indurated, same as above, grades into:	
	577			$\approx 576.2'$ clay, well indurated, gray (5Y 7/2) w pale rd purple (5R 6/2)	
#24 578- 582	578				
	579			clay, well indurated, same as above	
	580				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 30 OF
WELL NO. GCB-1		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#25 582- 585	580			clay as described on sheet 29	
	581				
	582		581.3		
	583		1)	1) clay, well indurated, grey (5Y 7/2)	
#26 585- 592	584		2)	2) Sand, m to vll (350 to 1000 or 8000 or) well sorted, off white (1Y) to pale grey (10Y 7/2) subang to subrd, dminerals: common to plentiful	
	585		584		
	586		3)	3) Sand, m to vll (250 to 2000 or) granules & pebbles (15 to 20% 2 to 7 mm thick) poorly sorted, med pink (5R 7/4) to pale org (10YR 7/2) w off white (10Y), subang, dminerals common mica: rare	
	587		4)	4) Sand, m to vll (250 to 1000 or) med to well sorted, off white (1Y) to pale org (10YR 7/2), ang to subang, dminerals: common, mica: rare, clay balls present = 5 to 10 mm in diameter	
#27 592- 596	588		5)	5) Sand, m to vll (350 to 8000 or) granules (20% 2 to 4 mm thick) poorly sorted, off white (1Y) to pale org (10YR 7/2), ang to subang dminerals: common	
	589				
	590				
	591				
#28 596- 599.5	592		591.9		
	593		6)	6) Sand, m to vll (350 to 2000 or) med to well sorted, pale org (10YR 7/2), subang dminerals: common	
	594		7)	7) clay, med indurated (silty), pale org (10YR 7/2), iron oxide staining of sand above & below clay, med rd (5R 1/6)	
	595		8)	8) Sand, m to vll (250 to 1410 or) well sorted, med org pink (10R 7/4), ang, dminerals: rare	
#29 599.5- 600	596		595.6		
	597		9)	9) Sand, m to vll (350 to 2000 or) granules (10% 2 to 4 mm thick) poorly to med sorted, pale org (10YR 7/2) subang	
	598		10)	10) clay lamina = 20 mm thick, med indurated, grey (5Y 7/2)	
	599		598.6		
	600			No recovery	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 31 of
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

Box	RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
58	#30 605-606	600				
		601				
		602				
		603			No Recovery	
		604				
		605				
		606				
		607			No Recovery	
		608				
		609				
		610				
		611				
		612				
		613				
		614				
		615				
		616				
		617				
		618				
		619				
		620				

#31 606-607	606					
#32 607-609	607					
	608					
	609					
#33 609-612	609					
	610					
	611					
	612					
#34 612-616	612					
	613					
	614					
	615					
	616					
#35 616-620	616					
	617					
	618					
	619					
	620					

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 32 OF
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

Run Number	Depth, Feet	Lithology	Percent Recovery	Sample Description	Drilling Comments
Box 60 #36 620-620.5 #37 620.5-621	620			clayey sand, f. to f. (125 to 250 μ) well sorted, upale org (10YR 7/2) to gray org pink (5YR 7/2) ang	
	621		①	U. micaceous, clay (25 to 30%) clayey texture	
	622		②	1) Sand, highly iron oxide staining of sand, ch to vcl (500 to 1410 μ) well sorted, mod brown (5YR 3/4) to dusky rd (10R 3/2) ang to subang, dhminerals: abundant	
	623			2) iron oxide amt $\approx$ 15 to 20 mm thick	
	624		623.7	3) Sand, mlt to vcl (250 to 710 μ , 2000 μ) mod to well sorted, gray org (10YR 7/4) ang, dhminerals: common grades into:	
	625			$\approx$ 622.5' Sand, ch to vcl (500 to 2000 μ) granules (10 to 2 mm thick) mod to well sorted, gray org (10YR 7/4) subang, dhminerals: rare	
Box 61 #38 627-632	627		③	3) Sand, ch to vcl (500 to 2000 μ) same as above	
	628		④	numerous thin clay laminae $\approx$ 10 to 15 mm thick, gray org, pink (5YR 7/2)	
	629			4) Sand mlt to vcl (850 to 1410 μ) mod sorted, gray org (10YR 7/4) ang to subang, grades into:	
	630		629.7	$\approx$ 629' Sand, ch to vcl (500 to 8000 μ) granules (10 to 15 μ to 4 mm thick) mod sorted, gray org (10YR 7/4) subang to subrd	
	631			numerous clay laminae $\approx$ 629.5' $\approx$ 5 to 10 mm thick, gray org, pink (5YR 7/2)	
	632		⑤	5) Sand, mlt to vcl (350 to 2000 μ) granules (5 to 10 μ to 4 mm thick) mod sorted, gray org (10YR 7/4) to upale org (10YR 5/2) subang, dhminerals: common	
Box 62 #39 632-633.5 #40 633.5-636	633		⑥	iron oxide amt $\approx$ 5 mm thick w staining above & below, dusky rd purple (5R 3/2)	
	634			6) Sand, f. to mlt (177 to 500 μ) well sorted, upale org (10YR 8/6) ang to subang	
	635		634.9	Sand, mlt to vcl (350 to 2000 μ) mod to well sorted, gray org (10YR 7/4) subang to subrd, dhminerals: rare	
	636			clay laminae $\approx$ 80 mm thick, well indurated, gray org (10YR 7/4)	
Box 63 #41 636-639	637			Sand, mlt to vcl (250 to 2000 μ) mod sorted, gray org (10YR 7/4) ang to subang, dhminerals: common, mica: rare	
	638			clay laminae $\approx$ 638.8' $\approx$ 30 mm thick, off white (L5) to upale org (10YR 5/2)	
Box 64 #42 639-644	639		638.9		
	640			Sand, as described on sheet 33	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 33 OF
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
64	64.0				
64	64.1			Sand, fluvial (177 to 500+) well sorted, gray (10YR 7/4) and clay balls present $\approx$ 5 to 10 mm thick in diameter	
64	64.2				
64	64.3			clay e base of run $\approx$ 12 cm thick, off white (9Y) to pale gray (10YR 7/2) well indurated	
64	64.4		64.3.1		
64	64.5			Sand, microcl (350 to 1000+) well sorted, gray (10YR 7/4) and dh minerals: varr mica: rare clay balls present $\approx$ 5 mm in diameter	
64	64.6				
64	64.7		64.6.1		
64	64.8			Sand, alt to vel (710 to 2000+) granules (10% to 4 mm thick) mod sorted, gray (10YR 7/4) subang.	
64	64.9				
64	65.0		64.9.3		
64	65.1			Sand, alt to vel (710 to 2000+) granules, same as above	
64	65.2				
64	65.3		65.2.4		
64	65.4			Sand, ml to ch (250 to 710+ 1410+) well sorted, gray (10YR 7/4) and clay lumps $\approx$ 10 mm thick base of run, pale gray (10YR 7/2)	
64	65.5				
64	65.6				
64	65.7			1) Sand, ml to vel (350 to 1410+) mod sorted, off white (9Y), ang to subang, mica: common grades into:	
64	65.8			2) Sand, alt to vel (710 to 2000+) granules (10% to 15%, 2 to 4 mm thick) mod to well sorted, gray (10YR 7/4) ang to subang, dh minerals: common	
64	65.9				
64	66.0				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 34 OF
WELL NO. GCB-1		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#48 660- 666	66.0		3)	1) iron oxide cmt = 15mm thick, med brown (5YR 3/4)	
	66.1			Sand, ml to well (350 to 2000) granules + pebbles (15 to 20% 2 to 15mm thick), poorly sorted, upale org (10YR 8/2) subang, d hminerals: common	
	66.2			numerous thin clay laminae = 5 to 10mm thick, gray org (5YR 7/2) to upale org (10YR 8/2)	
	66.3		66.3.1		
	66.4				
	66.5				
#49 666- 670	66.6		1)	1) Sand, ml to well (250 to 2100) well sorted, upale org (10YR 8/2) ang, numerous clay laminae = 5 to 7mm thick w clay balls present	
	66.7		2)	2) Sand, ml to well (250 to 2000) granules (15% 2 to 4mm thick) poorly sorted, gray org (10YR 7/4), ang to subang	
	66.8		66.8.1	base sand	
	66.9				
#50 670- 673	67.0				
	67.1			Sand, sh to well (500 to 2000) well sorted, gray org (10YR 7/4) subang to ang, d hminerals: common	
	67.2		67.2.8		
#51 673- 678	67.3				
	67.4		3)	3) Sand, ml to well (350 to 2000) granules (20% 2 to 4mm thick) poorly sorted, upale org (10YR 8/2) to pale rd purple (5RP 6/2), ang to subang, grades into	
	67.5			* Possible Contact for Cape Fear Fm @ 67.5	
	67.6		4)	4) by descent, Sand, ml to well (350 to 2000) granules + pebbles (30 to 40% 2 to 25mm thick) pale purple (5P 6/2) subang to subnd, clay (10%), d hminerals: plentiful	
	67.7				
#52 678- 679	67.8				
#53 679- 680	67.9		67.9.8	Sand to clay, fl to ell (175 to 1000 to 1410) well sorted, mottled pale pink (5RP 8/2) to gray rd purple (5RP 4/2), pale rd purple (5RP 6/2), gray purple (5P 4/2) wRP, indurated	
	68.0			Sand w clay same as above, well indurated	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 35 OF
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#51 680- 682	68.0			1) Sand w/ clay, mix to well (350 to 2000+) granules + pebbles (10% 2 to 7mm thick) subang to subrnd, mica: common, dh minerals: common, clay (20% or 6)	
#52 682- 683	68.1		1)		
#53 683- 686	68.2		68.2	2) Sandy/silty clay, well indurated, w/ gray (5Y 7/2)	
	68.3		68.3	Sandstone/siltstone, well indurated, lithified mottled w/ gray (5Y 7/2) w/ med red (5R 4/6) & pale red purple (5R 6/3) stringers	
	68.4		100%		
	68.5			Sandstone/siltstone, same as above	
#54 686- 687	68.6			No Recovery	
#55 687- 689.5	68.7				
	68.8			Sand w/ clay, well indurated, less lithified, sand ch to well (500 to 2000+) granules (10% 2 to 4mm) mottled, pale red, purple (5R 6/3), pale pink (5R 4/3), gray purple (5P 4/2) ang to subang, mica: rare, clay (15 to 20%)	
#56 689.5- 690	68.9		68.9	No Recovery	
#57 690- 692	69.0			Sand same as above clay (10 to 15%), well indurated	
#58 692- 695	69.1		69.1		
	69.2				
#59 695- 698	69.3			Sand, well indurated, less lithified same as above	
	69.4			change in color to a med light gray (206)	
	69.5		69.5	well indurated	
	69.6		Transgressive 1/2 deposit	Sand, ch to well (500 to 2000+) granules (10 to 15% 2 to 11mm thick) mostly round sorted, med light gray (206), subrnd, clay (15%) grades into	
	69.7			marrying down ward, pebbles increased to granules (30% 2 to 10mm thick)	
#60 698- 700	69.8		100%	Sharp contact @ 69.4' clay, well indurated med light gray (206) * Possible Sapropelite or Unnamed Fm. @ 69.5'	
	69.9			Siltstone, well indurated, lithified, numerous veins fill w/ dark clay, med dark gray (206)	
	70.0			possible Sapropelite but we see elastic material down hole	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 36 OF
WELL NO. 6613-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#64 700-706	700			Siltstone, sapropelite?, well indurated, med light grn (U6)	
	701			numerous veins, med drk grn (U4)	
	702			lenses like chert (groups) but no iron oxide stains; med rd brown (10R 4/6) to dk rd brown (10R 3/4)	
	703			at 702.5 from well to med indurated, more of a clay	
	704		703.4	clay, med indurated, med light grn (U6)	
	705				
#65 706-708.5	706				
	707			Sand, sh to v. (500 to 2000 or) well sorted, med light grn (U6) ang to sub ang clay (5 to 10%)	
#66 708.5-712	708		708.4		
	709				
	710			clay, med indurated, not lithified, med light grn (U6)	
	711			mottled med light grn (U6) to med drk grn (U4)	
	712		711.9	numerous veins, med drk grn (U4)	
#67 712-718	713		712.8	clay, same as above	
#68 715-715	714		713.5	1) Sand, ml to v. (350 to 2000 or) granules (10% 2 to 4 mm thick) pebbles (5% 4 to 7 mm thick)	
	715			(lay deposit), med light grn (U6) sub ang to sub med, clay (25%)	
#69 715-716	716		100%	sharp contact at 713.8'	
#70 716-718	717			2) clay, med to well indurated, med light grn (U6)	
#71 718-722	718		100%	clay, med to well indurated, med light grn (U6) mottled (pink) to med drk grn (U4)	
	719			clayey Sand, ml to v. (350 to 2000 or) granules + pebbles (30 to 40% 2 to 30 mm thick), poorly sorted, med light grn (U6), ang to sub med, feldspar present	
	720			clayey Sand, as above	
				5%	
				decrease in pebbles & granules (5%)	
				sandy/silty clay at 719.5'	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 37 OF
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#172 722- 723	720			sandy/silt clay, well indurated, as described on sheet 36	
	721			sharp contact @ 721' large grz pebble concentrated @ 721' ang to subang (4 to 30mm)	
	722			clay/Saprolite, well indurated, yw grn (5Y 5/1) mottled w veins - med light grn (5Y 5/1) & iron oxide staining (fast) med yw (5Y 7/6) w light olive brown (5Y 5/1) w	
#173 723- 727	723			dk rd brown (10R 3/4) + med rd (5R 4/6), yw grn (5Y 7/2)	
	724			clay/Saprolite same as above	Possible Saprolite Contact @ 72
	725			clay/Saprolite same as above, well indurated	
#174 727- 731	727		726.7		
	728			clay/Saprolite same as above, well indurated	
	729			grn grn (10G 4 5/2) & mottled w same colors as above	
#175 731- 736	730				
	731				
	732			Saprolite/clay, well indurated, dk rd brown (10R 3/4) to v. dk rd (5R 3/6)	
	733				
	734			From 734.5 to 735.5 looks a rubble zone, rip ups from 5 to 40mm thick	
#176 736- 742.4	735			@ 735.5 #1 Weathered Chlorite Schist *	
	736				
	737			weathered chlorite schist	
	738			highly foliated, dk minerals follows foliation, possibly biotite but looks metallic	
	739			dark yw grn (10G 4 3/2) w grn olive grn (5G 8 3/2)	
	740				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 38 of
WELL NO. GCB-1		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
740	740	///			
741	741	///		weathered chlorite schist same as above	
742	742	///		light olive (10Y 5/4)	
743	743	///		chlorite schist	
744	744	///		chlorite schist	
745	745	///			
746	746	fracture ///		chlorite schist	
747	747	///			
748	748	///			
749	749	///		chlorite schist	
750	750	///			
751	751	///			
752	752	///	751.8		
753	753	///		weathered chlorite schist	
754	754	///		light olive (10Y 5/4) to dusky gray (10G 4 3/2)	
755	755	///		highly fractured	
756	756	///			
757	757	///			
758	758	///			
759	759	///			
760	760	///			

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 39 of
WELL NO. GCB-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
759	760			chlorite schist	
759	761			light olive (10Y 5/4) to gray olive (10Y 7/2)	
#84 762- 762.3	762				
#85 762.3- 766.3	763				
	764			chlorite schist	
	765				
#86 766.3- 769.3	766				
	767				
	768			Chlorite Schist	
	769				
#87 769.3- 771.5	770			qtz veins	
	771			light olive (10Y 5/4) to pale olive (10Y 6/2)	
#88 771.5- 774	772			highly fractured	
	773			Contrast 773.5' Possible Gneiss	
#89 774- 781	774				
	775			Gneiss	
	776			med bluish gray (50%) to light bluish gray (50%)	
	777			Feldspar Qtz, Biotite Gneiss	
	778			Fine-grained, highly foliated	
	779				
	780				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 40 of
WELL NO. 60B-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	180				
#70 181- 185.8	181			Gneiss Feldspar, Qz, Biotite, foliated	
	182				
	183				
	184				
	185				
#71 185.8- 187.4	186				
	187			Highly fractured	
#72 187.4- 191.0	188				
	189			Gneiss	
	190				
#73 191- 199	191				
	192			Gneiss dk gry (23) to gmbk (56%) from 192 to 194	
	193				
	194				
	195			qtz following foliation	
	196				
	197			gry blue gm (50% 5/2)	
	198				
#74 199- 202.3	199				
	200				

Box
263
77Box
273
78

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 41 OF
WELL NO. 6013-1		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#95 802.3 802.7	800			qt veins 2mm thick in white fine grain Gneiss	
	801				
	802				
	803				
	804				
	805				
	806				
	807				
	808				
	809				
	810				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				

Core Hole: # GCB-2

6-4-96

Rotary down to 12 ft.

		<u>Recovered:</u>
Run 1	12'-17'	4' 13-17'
Run 2	17-20'	1' 19-20'
Run 3	20-25'	4' 21-25'
Run 4	25-30'	3.8' 26.2-30'
Run 5	30-33'	4" 32'8"-33'
Run 6	33-40	no recovery
Run 7	40-45'	no recovery
Run 8	45-51	9" 50'3"-51'
Run 9	51-55	no recovery
Run 10	55-60	no recovery

6-6-96

mud viscosity: 51 sec

Run 11	60-65'	4'5" 60'7"-65'
Run 12	65-71'	6' 100%
Run 13	71-75'	2'8" 72'4"-75'
Run 14	75-76'	3' 75'9"-76
Run 15	76-80'	2'7" 77'5"-80'
Run 16	80-85'	4'8" 80'4"-85'
Run 17	85-91'	4'6" 86'6"-91'
Run 18	91-95'	100%
Run 19	95-97'	Lost 96'1"-96'8"
Run 20	97-100	2' 98-100'
Run 21	100-105	no recovery

6-7-96

Run 22	105-109	3' 106-109'
Run 23	109-112	10" 109-109'10"
Run 24	112-114	9" 113'3"-114'
Run 25	114-117	no recovery
Run 26	117-120	no recovery
Run 27	120-123	1'3" 121'9"-123'
Run 28	123-127	1'8" 125'4"-127'
Run 29	127-131	4' 100%
Run 30	131-135'	1'7" 131-132'7"

mud viscosity: 63 sec

Run 31	135-141	100%
Run 32	141-144	2'5" 141-143'5"
Run 33	144-147	2'9" 144'3"-147'
Run 34	147-152	9" 147-147'9"

Recovered:

Run 35	152-153	10"	152-152'10"
Run 36	153-157	100%	
Run 37	157-164	100%	

6-8-96

Run 38	164-172	100%	
Run 39	172-181	100%	
Run 40	181-187'4"	6'4"	100%
Run 41	187'4"-189'5"	100%	
Run 42	189'5"-193'	3'4"	189'5"-192'9"

mud viscosity: 51 sec

Run 43	193-196	100%	
Run 44	196-198'6"	100%	
Run 45	198'6"-205'	5'	198'6"-205'
Run 46	205-212	6'6"	205-211'6"
Run 47	212-217	3'8"	212-215'8"
Run 48	217-225	6'2"	217-223'2"
Run 49	225-232	5'10"	225-230'10"
Run 50	232-241	6'10"	232-238'10"
Run 51	241-245	2'8"	241-243'8"
Run 52	245-252	5'5"	245-250'5"
Run 53	252-256'2"	4'2"	100%
Run 54	256'2"-257'	100%	
Run 55	257-264	100%	
Run 56	264-268'5"	3'7"	264-267'7"
Run 57	268'5"-273	100%	

6-9-96

mud viscosity: 54 sec mud weight: 8.85 lbs/gal

Run 58	273-277	100%	
Run 59	277-284	6'4"	277-283'4"
Run 60	284-292	6'10"	284-290'10"
Run 61	292-300	6'10"	292-298'10"
Run 62	300-306	5'2"	300-305'2"
Run 63	306-313	4'7"	306-310'7"
Run 64	313-320	6'3"	313-319'3"
Run 65	320-326	5'7"	320-325'7"
Run 66	326-333	3'9"	326-329'9"
Run 67	333-336	2'2"	333-335'2"
Run 68	336-343	5'6"	336-341'6"
Run 69	343-351	5'3"	343-347'3"
Run 70	351-358	5'10"	351-356'10"
Run 71	358-365	6'1"	358-364'1"
Run 72	365-373	6'2"	365-371'2"

lost circulation 500 gals

6-10-96

Recovered:

Run 73	373-380	6'3"	373-379'3"
Run 74	380-386	5'4"	380-385'4"
Run 75	386-393	7'	100%
Run 76	393-395	1'4"	393-394'4"
Run 77	395-402	5'1"	395-400'1"
mud viscosity: 47sec mud weight: 8.8 lbs/gal			
Run 78	402-404'8"	2'4"	402-404'4"
Run 79	404'8"-413'4"	8'7"	404'8"-413'3"
Run 80	413'4"-419	5'6"	413'4"-418'10"
Run 81	419-421	100%	
Run 82	421-426	3'10"	421-424'10"
Run 83	426-433	6'5"	426-432'5"
Run 84	433-440	5'	433-438
Run 85	440-447	6'6"	440-446'6"
Run 86	447-453	5'8"	447-452'8"

6-11-96

Run 87	453-460	6'6"	453-459'6"
Run 88	460-464	2'8"	460-462'8"
Run 89	464-471	4'7"	464-468'7"
Run 90	471-475	3'	471-474
Run 91	475-477	1'10"	475-476'10"
Run 92	477-480	2'	477-479
Run 93	480-485	3'1"	480-483'1"
Run 94	485-492	6'2"	485-491'2"
mud viscosity: 78sec mud weight: 8.8 lbs/gal			

6-20-96

Run 95	492-493'6"	100%	
Run 96	493'6"-498'	4'1"	493'6"-497'11"
Run 97	498-501	1'8"	498-499'8"
Run 98	501-508	100%	
Run 99	508-509'4"	100%	
Run 100	509'4"-513	3'	509'4"-512'4"
Run 101	513-517	2'9"	513-515'9"

6-21-96

Run 102	517-521	1'3"	517-518'3"
Run 102A	521-523	9"	521-521'9"
Run 103	523-532	no recovery	
mud viscosity: 55sec mud weight: 8.7 lbs/gal			
Run 104	532-535	2'7"	532-534'7"
Run 105	535-541	2'7"	535-537'7"
Run 106	541-545	3'4"	541-544'4"

6-21-96

Run 107 545-552

Run 108 552-557

Run 109 557-562

Recovered:

6' 545-551

4'10" 552-556'10"

3' 557-560

6-23-96

Run 110 562-567

Run 111 567-568

Run 112 568-568'4"

Run 113 568'4"-572

Run 114 572-576

Run 115 576-580

Run 116 580-586

Run 117 586-592

Run 118 592-595

Run 119 595-595'6"

Run 120 595'6"-597

2'10" 562-564'10"

9" 567-567'9"

no recovery

no recovery

3" 572-575

3'3" 576-579'3"

4'5" 580-584'5"

3'7" 586-589'7"

1'1" 592-593'1"

no recovery

11" 596-596'5"

6-25-96

Run 121 597-600

Run 122 600-603'6"

Run 123 603'6"-605

Run 124 605-607

Run 125 607-611

Run 126 611-615

Run 127 615-616

Run 128 616-618

Run 129 618-620

1'6" 597-598'6"

2'1" 600-602'1"

5" 604'7"-605

100%

2'9" 607-609'9"

10" 614'2"-615

100%

5" 616-616'5"

no recovery

6-28-96

Run 130 620-625

Run 131 625-629

Run 132 629-632

Run 133 632-635

Run 134 635-640

Run 135 640-645

Run 136 645-648

Run 137 648-651

Run 138 651-655

Run 139 655-657

Run 140 657-660

Run 141 660-665

Run 142 665-671

Run 143 671-673

4'11" 620-624'11"

3'2" 625-628'2"

2'8" 629-631'8"

100%

100%

4'5" 640'7"-645

100%

100%

100%

100%

2'8" 657-659'8"

100%

5'7" lost 666'-666'5"

100%

6-29-96

Recovered:

Run 144 673-675

4'1" 100%

Run 145 675-676

11" 675-675'11"

Run 146 676-680

3'10" 676-679'10"

Run 147 680-683'3"

100%

Run 147 683'3"-684

100%

TD = 684'

FIELD GEOLOGIC LOG

PROJECT		DATE 6-4-96	SHEET 1 OF
WELL NO. GCB-2		REFERENCE DATUM Land surface elev: 221	DRILLING CONTRACTOR (USGS-WRI)
LOGGED BY Kevin J Conlan		SAP COORDINATES	DRILLER Todd Hunter
		COMPANY USGS-WRI	DRILLING METHOD Wire line core

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	0				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
#1 12-17	12		80%		
	13			granules (1 to 2 mm thick)	
	14			Sand fill to well (177 to 2000 ft) poorly sorted, med red brown (10R 4/6), submed to subang	
	15			clay (5 to 10%)	
	16			sharp contact is a clayey sand fill to well (177 to 5000 ft) med sorted, dk grey org (10YR 6/6)	
	17		33.3%	subang to submed, clay (10-20%), clay content & decrease $\approx 16.6\%$	
#2 17-20	17			numerous thin sand laminae ≈ 1 to 2 mm thick, of 11 (80 to 125 ft) v light grey (10R 8)	
	18				
	19		19	clayey sand (as above) grades into: Sand m to med (2500-12000 ft, 1/100) poorly to med sorted,	
				dk grey org (10YR 6/6), subang, clay ($\leq 5\%$)	
	20		20	thin laminae ≈ 1.6 ", clay content increases, grey red (10R 4/2)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 2 of 4
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. 6413-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#3 20'-25'	20		80%		
	21		21	Sand Fr 11 (125-250 ϕ) well to med sorted, Dk yellowish orange (10YR 6/6)	
	22			subnd to subang clay < 2%	
	23			mica - rare (muscovite)	
	24			mica increase (rare to common) (subnd)	
#4 25-30	25		76.6%		
	26		26.2	Sand Fr 11 (125-250 ϕ) well to med sorted, Dk yellowish orange (10YR 6/6)	
	27			subnd to subang clay < 1%	
	28			mica - rare dark minerals present (rare to common)	
	29			Sand grades into light brown (5YR 5/6)	
	30			mica - common	
#5 30'-33'	31		11.1%		
	32				
#6 33'-40'	33		32.8%	Sand Fr IX (177-1200/1410 ϕ) med sorted, Dk yellowish orange (10YR 6/6)	
	34		0%	subnd to subang clay < 2%	
	35			dk minerals present	
	36			No Recovery	
	37				
	38				
	39				
	40				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 3 of
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. 6613-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#7 40-45'	40		0%		
	41				
Box 3 Box 4	42			No Recovery	
	43				
	44				
#8 45-51'	45		12.5%		
	46				
	47				
	48				
	49				
	50		50.3"	Sand M to C (250-710 1000 yr) w/ some grz pebbles (3 to 5 mm in diameter) subangular to subang, poorly to med sorted, Pale yellowish brown (10YR 6/2) dk minerals present	
#9 51-53'	51		0%	grades into a grayish yellow (5Y 8/4) sand FROM (25-500 yr) med sorted subangular to subang	
Box 4 Box 5	52				
	53				
	54			Sand M to C (250-710) poorly sorted subangular to subang, Dk yellowish orange (10YR 6/6)	
#10 55-60'	55		0%	This sample is not core, portions of it washed core	
	56				
	57			No Recovery	
	58				
	59				
	60				

FIELD GEOLOGIC LOG

PROJECT		DATE 6-6-76	SHEET 4 of
WELL NO. 6C13-2		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#11 60'-65'	60				
	61		60'7" 98.3%	Sand m to c (250-500) med sorted Dk yellowish orange (10YR 6/6) submed to subang dk heavy minerals mica: rare to common (muscovite).	
Box 5 Core 6	62				
	63				
	64			Thin clay beds 2 mm thick grayish yellow (5Y 8/4) interbedded with sand, mottled, light brown (5YR 5/6) to dk yellowish orange (10YR 6/6) sand. Bottom of run light brown clay (5YR 5/6)	
#12 65'-71'	* 65		100%	mica - rare	
	66			* Starting e. Run #12 used Solid Inner Core Barrel before used Split Inner Core Barrel	
	67			Mottled color sand same as above w interbedded clay lenses (2 to 5 thick)	
	68			Sand Fm C (177 to 600 ft (710)) med sorted Dk yellowish orange (10YR 6/6) subang to submed mica present - rare	
	69				
	70			sand size increase T m to c (350 to 1000 ft) 2 to 5 clay lenses still present	
Box 6 Core 8	71		66.6%		
#13 71'-75'	72		72.4"	Sand m to c (350 to 1410 ft) med sorted dk yellowish orange (10YR 6/6) subang, mica present	
	73				
	74			Thin clay lens present lower 1' from clay grayish yellow (5Y 8/4) 5.5 ft thick	
	75		25% 75.4"		
#14 75'-76'	76		64.5%	Sand Fm M (25 to 350) med sorted dk yellowish orange (10YR 6/6) submed to subang mica rare	
#15 76'-80'	77		77.5"		
	78			Sand Fm M (125 to 350) med sorted dk yellowish orange (10YR 6/6) submed to subang ~ 78' mottled clay light brown (5YR 5/6), grayish yellow (5Y 8/4)	
	79			below clay: Sand m to c (250 to 710 ft) med sorted dk yellow orange (10YR 6/6)	
	80				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 5 OF
WELL NO. 6613-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#16 80'-85'	80		80.4"		
	81		93.3%	Sand F to M (250 to 400+) mod sorted $\approx$ Grayish orange (10YR 7/4) subang to submed	
	82			Sand interbedded w/ clay lenses $\approx$ 2 to 5 mm thick, grayish yellow (5Y 8/4)	
	83			Sand varying color - Grayish orange (10YR 7/4) to dark yellowish orange (10YR 6/6)	
	84				
#17 85'-91'	85		75%		
	86		86.6"		
	87			1) Sand M (250 to 500+) mod sorted $\approx$ Pale grayish (10Y 8/2) clay 10 to 20% mottled to laminated (2 to 5 mm thick) pale Red purple to grayish yellow (5Y 8/4), submed to subang	
	88			2) clay dk gray org (10YR 6/6) grades into sequence of clay laminated to sand m	
	89			3) Sand F to M (175 to 410+) poorly to mod sorted $\approx$ grayish org (10YR 7/4) subang to ang, mica - rare	
	90				
#18 91'-95'	91		100%	Sand m to c (250 to 600+) mod sorted grayish org (10YR 7/4) submed to ang, mica - common to rare	
	92			clay 10% laminated (2 mm thick) grayish gray (5Y 8/4) to light white (N9)	
	93			sand size increases F to UCL (170 to 1410+) subang to med, mod to poorly sorted	
	94			Iron stained sands above clay $\rightarrow$ cement sand grain (light purple)	
	95			clay Dk gray org (10YR 6/6)	
#19 95'-97'	96		70.8%	1) Clay, mottled, grayish org (10YR 7/4) to Dk gray org (10YR 6/6)	
	97		66.6%	2) Thin sand to iron stained laminae (3% 2 mm thick) dusky red purple (5R 2/2) heavy minerals $\rightarrow$ abundant limonite	
#20 97'-100'	98			Sand f to c (195 to 600+) mod to poorly sorted grayish org (10YR 7/4) submed to subang, heavy minerals	
	99			clay (2%) laminated, pale greenish yellow (10Y 8/2)	
	100				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 6 OF
WELL NO. 6C13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#21 100-105	100				
	101		0%		
	102			No Recovery	
	103				
	104				
#22 105-108	105		75%	6-7-96	
	106		10%	clay laminae v light grey (108) to dk yw org (10YR 6/6), thin sand to iron oxide	
	107		2	stained cement laminae fu to ml (177 to 500) mod sorted, dk yw org (10YR 6/6) sub.	
	108		4	2) Sand fu to ml (177 to 350) mod to well sorted, dk yw org (10YR 6/6) subang to subbrd, heavy minerals: rare * heavy minerals - plentiful.	
	109		27.7%	3) clay v pale org (10YR 8/2)	
	110		105.10"	4) clay mottled v pale org (10YR 8/2) to light brown (5YR 6/4)	
#23 109-112	110			1) clay pale yw org (10YR 8/6) interbedded in the 2nd clay is a thin (2mm) iron oxide	
	111			stained sand ml to ch (250 to 710) mod sorted, subang, v dusky rd purple (5RP 2/6)	
	112		37.5%	2) sand fu to chl (177 to 1000) mod to poorly sorted, dk yw org (10YR 6/6) subang Sand in contact w clay - iron oxide (staining) present, v dusky rd purple (5RP 2/6)	
#24 112-114	113		113.3"	1) Sand ml to chl (250 to 1200) mod to poorly sorted, dk yw org (10YR 6/6) subbrd to subang	
	114			2) clay laminae (10 to 30 mm thick) v pale org (10YR 8/2) to pale yw org (10YR 8/6)	
#25 114-117	115		0%		
	116			No Recovery	
#26 117-120	117		33.3%		
	118				
	119		*	* Note * recovered the last line of the run was washed out - No Recovery	
	120		*	Sand, fu to ml (177 to 500) mod sorted, mod yw brown (10YR 5/4) heavy minerals present	
				end of run: clay, pale yw org 10YR (8/6)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 7 OF
WELL NO. 6013-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#29 120-123	120		41.6%		
	121				
	122			1) clay, pale greenish, uw (10YR 8/2)	
	123			2) Sand, fl to ml (175 to 500+) mod to well sorted, drk yw org (10YR 6/6)	
				clay, laminae, 3/8, pale greenish uw (10YR 8/2)	
#28 123-127	123		41.6%	3) clay, pale greenish yw (10YR 8/2), sand, interbedded (2 to 5 mm thick)	
	124			ultrastky red purple (SRP 2/2), ml to cl (250 to 600+) mod sorted	
	125			heavy minerals present, mica - rare	
	126				
	127				
#29 127-131	127				
	128			Sand fl to ml (125 to 500+) mod sorted, drk yw org (10YR 6/6)	
	129			subnd to subang, drk heavy minerals rare, mica - rare	
	130				
	131			Sand ml to ml (250 to 500+) mod to well sorted, drk yw org (10YR 6/6)	
				subnd to subang, drk heavy minerals rare, mica - rare	
	132				
	133			minimus clay (10 to 15%) laminae, (2 to 10 mm thick), pale yw org (10YR 8/6)	
	134			* sand in contact w clay horizon near side entry	
	135			ultrastky red purple SRP 2/2	
#30 131-135	131		4) 39.5%	4) Sand fl to cl (175 to 100+) (1410+), pebbles (2 to 5% 5mm)	
	132			mod to poorly sorted, drk yw org (10YR 6/6), subnd to subang,	
	133			w numerous 2 mm thick laminae of clay, pale yw org (10YR 8/6)	
	134			5) clay = 5 mm thick, pale yw org (10YR 8/6), drk red (SR 3/4) staining of sand	
	135			in contact w clay	
	136			6) Sand, fl to vll (175 to 1500+) poorly sorted, granules (2 to 5% 5mm), drk yw org (10YR 6/6)	
	137			subang, clay, laminae, 1 to 2 mm thick, pale yw org (10YR 8/6)	
#31 135-141	135		100%	7) Sand, ml to cl (250 to 700+) mod sorted, drk yw org (10YR 6/6), subang to subnd,	
	136			numerous clay laminae (30% 1 to 2 mm), pale yw org (10YR 8/6), mica - rare	
	137			drk red (SR 3/4) staining of sand along clay laminae	
	138			grading down to:	
	139			8) sand ml to cl (350 to 1000+) poorly to mod sorted, granules (2 to 5% 10 mm thick)	
	140			clay (SR 1/2) laminae, pale yw org (10YR 8/6), grading down to:	
				9) Sand cl to vll (710 to 2000+) poorly to mod sorted, granules (5 to 10% 10 mm thick)	
				ang to subang, clay (5% 1 mm thick) laminae, pale yw org (10YR 8/6)	
				drk red (SR 3/4) staining of sand along clay	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 8 OF
WELL NO. 6C13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#32 141-144	140		9)	9) same as above	
	141		80.5	pebbles (5% 10mm thick)	
	142			Sand, med to, well (350 to 2000), med sand, dk grey org (DPR 6/6) to Grayish org 10YR 7/4 subang to submed, dk heavy minerals: rare	
	143		143.5"		
#33 144-147	144		144.3"	1) Sand fl to well (157 to 2000), pebbles (10 to 20%, 10 to 15 mm thick) med to med sand, clay (<5%) med brown (5YR 4/4), submed to subang	
	145		91.6%	clay content increases = 145.6" * = 6cm thick zone of grayish red purple (5RP 4/2) staining of sand, lg granules (30/2, 1.5 to 2 mm thick)	
	146		2)	2) clay, mottled, pale rd purple (5RP 6/3) w white (N9) * possible K/T contact	
#34 147-152	147		150%		
	148		147.5"	clay, mottled, pale rd purple (5RP 6/2) w Grayish rd purple (5RP 4/2)	
	149				
	150				
	151				
#35 152-153	152		83.3%	Clay, mottled, pale rd purple (5RP 6/2) w white (N9)	
	153		152.10"		
#36 153-157	153		100%	Clay, mottled, light gray (N7) w md gray (N5)	
	154				
	155				
	156				
#37 157-164	157		166%	Clay mottled, light gray (N7) w md gray (N5) sand fl (157 to 2500) <1%	
	158				
	159				
	160			~ 159.6" mottled, light gray (N7) w Dusky rd (5R 3/4)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 9 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. 6613-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#38 164-172	160	---	100%	silty clay mottled, light gray (177) to med red brown (10R 4/6) sand (1 to 2%) f.u. (177 to 250, 500+) subang	
	161	---			
	162	---			
	163	---			
	164	---			
	165	---		clay, ? silty, mottled light gray (177) to med red brown (10R 4/6), pale rd purple (5RP 6/2), dk gray org (10YR 6/6) sand (1 to 2%) f.u. (177 to 250, 500+) subang to submed	
	166	---			
	167	---			
	168	---			
	169	---			
#39 172-181	170	---	100%		
	171	---		171'6" Whit. (179)	
	172	---			
	173	---		clay, silty, mottled light gray (178), med rd brown (10YR 4/6), pale rd purple (5RP 6/2), dk gray org (10YR 6/6) sand (1%) f.u. (177 to 250, 500+) subang to submed	
	174	---			
	175	---			
	176	---			
	177	---			
	178	---			
	179	---			
	180	---			

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 10 OF
WELL NO. 6013-2		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#40 181'- 181'4"	180				
	181		100%		
	182			clay, silty, mottled, drk yw org 10YR 6/6, med brn (10YR 4/6), pale rd purple (5RP 6/2), v light gray (108)	
	183			Sand (<1%) ml to vcl (350 to 1600r) subang to subnd	
	184			~184 mottled, drk yw org 10YR 6/6, light gry (107)	
	185			sand 5% starting @ ~184'	
	186			10%	
				20%	
				37%	
#41 181'4"- 181'5"	187		100%	~187' sandy clay, light gry (107), sand (30 to 40%), ml to vcl (350 to 2000r) subang to subnd	
	188		1)	1) clayey sand, ml to vcl (350 to 2000r) mostly to med sorted, med. light gry (N6) to med gry (105), subang to subnd, clay (20 to 30%)	
#42 181'5"- 183'	189		2)	2) clay, med gry (105), sand (5 to 10%)	
	190		3)	3) clayey sand, ml to vcl (350 to 1600r) med sorted, light gry (107) subang to subnd, clay (10%) mica: rare	
	191		4)	4) sand, cl to vcl (710 to 1500r) pebbles (5 to 10mm thick), med sorted, drk gry (103) chalcoprite staining on sand grains	
#43 183'- 186'	192		5)	5) clayey sand, ml to vcl (250 to 1000, 1300r) med sorted, mottled: pale rd purple (5RP 6/2), grayish rd purple (5RP 4/2), v dusky rd purple (5RP 2/2), subang to subnd, clay (10 to 20%) mica: rare	
	193		6)	6) clay, mottled, gry rd purple (5RP 4/2), white (107)	
	194			clayey sand, ml to vcl (250 to 1900r) med sorted, mottled: grayish rd purple (5RP 4/2), gry org (10YR 7/4), pale greenish gry (10YR 8/2) subang to subnd,	
	195			clay (5 to 10%), mica: common (10 to 40mm thick)	
#44 186'- 186'6"	196		100%		
	197			clayey sand ml to vcl (250 to 2000r) pebbles (7mm thick), med sorted, pale red (10R 6/2) subang to subnd, clay (5 to 10%) granules most concentrated @ ~198'	
	198				
	199		100%		
	200			clayey sand ml to vcl (250 to 2000r) med sorted, off white (107), subang to subnd drk heavy minerals common mica: common to plentiful, numerous thin (1mm) v dusky, purple (5P 2/2) staining of sand, clay (5 to 10%), kaolin?	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 11 OF
WELL NO. 6613-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	200			↓ decrease in clay content	
	201				
	202				
	203			clayey sand ml to vcll (250 to 2000+) pebbles (5% 4 mm) off white (U9), subang to subbrnd	
	204			dk heavy minerals: rare, mica: rare, clay (2%)	
#46 205- 212'	205		1) 92.5%	1) Sand, ml to vcll (250 to 2000+) pebbles (40-50% 60mm) off white (U9), subang to subbrnd	
	206		2)	2) dk heavy minerals: rare, mica: common, clay (5%)	
	207		3)	3) Sand, fl to ml (177 to 500+) med to well sorted, off white (U9), subbrnd to subang, dk heavy minerals: rare	
	208		4)	4) Sand, ml to vcll (250 to 2000+) pebbles (20% 2 to 3 mm) off white (U9), subang to subbrnd	
	209		5)	5) dk heavy minerals: rare, mica: rare, clay (2%)	
	210		6)	6) Sand, ml to vcll (350 to 2000+) pebbles (40%, 5 to 10 mm) off white (U9), subang to subbrnd	
	211		7)	7) dk heavy minerals: rare, mica: rare	
	212		8)	8) numerous thin laminar (3 to 7 mm thick) of dk heavy minerals	
#47 212- 217'	213		9) 93.3%	9) Sand, ml to vcll (250 to 2000+) off white (U9), subang to subbrnd, dk heavy minerals: common	
	214		10)	10) mica: common, clay (2-5%) silty texture	
	215		11)	11) silty sand/clay, off white (U9), silty texture, sand w/ll to sll (25 to 200+) med sorted, subbrnd	
	216		12)	12) mica: common to plentiful, dk heavy minerals: rare	
	217		13)	13) Sand, fl to ml (125 to 350+) med sorted, off white (U9), subang to subbrnd	
	218		14)	14) dk heavy minerals: common, mica: common to plentiful, clay (5-20%) (silty texture)	
#48 217- 225	219		15)	15) Sand, fl to ml (177 to 710+) med sorted, off white (U9), subbrnd, dk heavy minerals: common	
	220		16)	16) mica: common to plentiful, clay (5%) (silty texture) Grades down to	
			17)	17) Description on page 12	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 12 OF
WELL NO. 6C13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	220			pebbles, (10% 2 to 5 mm thick)	
	221		10)	10) Sand, ml to u/l (250 to 2000+), poorly to moderately, off white (U9), clayey to subnd, dk heavy minerals: common, mica: common to plentiful (2 to 4 mm thick), also (2 to 5%) (taken)	
	222				
	223		22 3/2"		
	224				
	225		83.3%	1) Sand, ml to u/l (250 to 2000+), granules, (40% 2 to 5 mm thick), poorly to moderately, off white (U9), dk heavy minerals: common, mica: rare, clay (5%) (taken)	
	226		1)		
	227		2)	2) clay, off white (U9)	
	228		3)	3) Sand, ml to u/l (250 to 2000+), pebbles (20% 2 to 4 mm thick), moderately, clayey to subnd, dk heavy minerals: common, mica: common to plentiful, clay (5%) taken, numerous clay laminae (5%, 2 to 8 mm thick), off white (U9), grades down to	
	229		4)	4) V. dark purple (off 2 1/2) matrix of sand = 10 to 20 mm thick, sand grains = 5 mm thick in thin zones (limestone)?	
	230				
	231		5) 230 10"	5) silty sandy clay, off white (U9), clay texture, sand u/l to f/l (88 to 200+), mod sorted, subnd, dk heavy minerals: rare, mica: common to plentiful	
	232		75.9%		
	233		6)	6) Sand, ml to u/l (250 to 2000+), pebbles (10% 2 to 5 mm thick), moderately, off white (U9), clayey to subnd, dk heavy minerals: rare, mica: common, clay (5%) taken	
	234				
	235				
	236		7)	7) silty clay, off white (U9)	
	237		6)		
	238				
	239		23 1/10"		
	240				

#49

225-232

233

234

#50

232-241

242

243

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 13 OF
WELL NO. 6613-2		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#51 241- 245	240				
	241		66.6%	sandy (rel.) 1) silty clay, off white (W), sand (20-30%) vfk to fvk (85 to 2000) med sorted, submed mica: common to plentiful, dk heavy minerals: rare.	
	242				
	243		71.3%	2) Sand, mt to vfk (257 to 2000) med sorted, light brown (5YR 6/4), subang to submed, dk heavy minerals: rare, mica: rare to common, clay (2-10%) grades down to	
	244			rel. sand, clay (4-10%) mica: common to plentiful	
	245		77.3%	3) Hard laminae = 1 to 2 mm thick v. dusky red (10R 2/3) staining of sand below hard laminae -> cemented heavy minerals -> iron oxidized.	
#52 245- 252	246				
	247			Sand, mt to vfk (257 to 2000) med sorted, off white (W) to light brown (5YR 6/4) subang to submed, dk heavy minerals: rare, mica: common to plentiful (2 mm thick) clay (5%) (taken)	
	248				
	249			4) hard laminae = 5 mm thick, v. dusky red (10R 3/4) to dk red brown (10R 3/4) staining of sand below hard laminae	
	250		250.5"		
	251				
#53 252- 256.2	252		100%	4) hard laminae = 10 mm thick, v. dusky red (10R 3/4) to dk red brown (10R 3/4) staining of sand below laminae: iron oxidized, cemented	
	253			5) numerous thin laminae (2 to 5 mm thick), v. dusky red (10R 3/4) staining of sand	
	254				
	255			5) Sand fvk to vfk (177 to 1000) med sorted, off white (W), subang to submed micaceous: common to plentiful, dk heavy minerals: rare looks like bedding: alternating sequences of clean sand to micaceous sand clay (5-10%) rel. texture	
#54 256.2- 257	256		100%	6) clay, white (W), mottled to pale rd purple 5RP (6/2)	
#55 257- 264	257		100%		
	258			clay, mottled, white (W), pale rd purple 5RP (6/2), v. dark rd (5R 2/6) mica, fl to fvk (125 to 2500), common	
	259				
	260				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 14 OF
WELL NO. 6613-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	260		100%		
	261			Description above	
	262				
	263				
	264		81.1%		
	265			clay, light greenish gray (SGY 8/1) to greenish red purple (SRP 4/2) laminae mica common, drk heavy minerals: rare	
	266				
	267		267 9"		
	268				
	269		100%		
	270			clayey sand, off white (W9) to light greenish gray (SGY 8/1), sandy texture, clay (10 to 30%) sand up to 1/4" (88 to 2000), med sorted, submed	
	271			drk heavy minerals: rare to common - some lamination in dk m mica: common to plentiful	
	272			* v dusky purple (SRP 2/2) staining of sand (laminae)	
	273		100%		
	274			1) Sand, ml to vel (250 to 1410 or 1400), pebbles (10%, 5 to 7 mm) poorly to med sorted off white (W9) to light greenish gray (SGY 8/1), subang to submed, degrades down into:	
	275			drk heavy minerals: rare to common, mica: common to plentiful clay (10-20%)	
	276			2) clay white (W9) = 20mm thick, sand grains within (5 to 2%)	
	277		90.4%	3) Sand, vel to vcl (1000 to 2000), granules (5% 5 mm) med sorted, submed	
	278			4) clay, white (W9) = 50 mm thick, sand (5 to 10%)	
	279			5) Sand ml to vcl (250 to 2000), pebbles (10% 5 to 7 mm) poorly to med sorted off white (W9) to light greenish gray (SGY 8/1), subang to submed	
	280			drk heavy minerals: rare, mica: common, clay (10 to 20%)	

#56
264'-
268.5'

#57
268.5'-
273'

#58
273'-
277'

#59
277'-
284'

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 15 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. 6013-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	280			5) described as above	
	281			6) moderate brown 5YR 3/4 staining of sand grains ≈ 30 to 40 mm thick, center of zone	
	282			hard iron oxidized cemented laminae	
	283			7) Sand, ml to cl (250 to 1000 g) mod sorted, subang to subrnd, off white (10Y),	
	284			fine texture, drk heavy minerals: rare mica: common to plentiful	
	285			clay (10 to 20%)	
	286			grades down into: $C \approx 285'6"$	
	287			Sand, fl to vel (200 to 2000 g) pebbles (20 to 25%, 5 to 10 mm) poorly to mod sorted,	
	288			off white (10Y) to light gray (5GY 8/1), subang to subrnd, clay (5%)	
	289			drk heavy minerals: common to plentiful; mica: common to plentiful - some ≈ 2 to 3 mm in length	
	290			numerous thin laminae of concentrated drk heavy minerals ≈ 1 to 2 mm thick	
	291			numerous thin laminae of clay, off white (10Y) ≈ 1 to 2 mm thick	
	292			$C \approx 290'$ clay laminae ≈ 35 mm thick, off white (10Y)	
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FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 16 OF
WELL NO. 6013-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#62 300'- 306'	300		86.1%	1) Sand ch to well (500 to 2000 gr) pebbles (20 to 25% 4 to 6 mm thick, poorly to mod sorted, off white (10Y) to dk grey (10YR 6/6), subang to subrnd, clay (5%)	
	301		1)	dk heavy minerals: common mica: common	
	302		2)	numerous thin clay laminae = 1 to 2 mm thick - distorted	
	303			2) clay, off white (10Y) 20 to 40 mm thick	
	304		3)	3) Sand mt to ch (250 to 1000 gr), mod to well sorted, off white (10Y) to light grey (5GY 8/1)	
	305		305' 2"	subang, dk heavy minerals: rare to common, mica: common to plentiful	
				taffy texture, clay (20 to 25%)	
#63 306'- 313'	306		65.4%	4) Same as #3 above	
	307		4)	numerous thin laminae of concentration of dk heavy minerals = 3 to 5 mm thick	
	308			(all) * the laminae are = 45° off horizontal bedding	
				sharp lithologic change (contact) c = 306' into:
	309		5)	5) Sand, mt to well (250 to 2000 gr) pebbles (5 to 10% 2 to 4 mm thick), poorly to mod sorted,	
	310		310' 9"	dk grey (10YR 6/6), subang to subrnd, clay (< 2%)	
				dk heavy minerals: rare to common, mica: common	
#64 313'- 320'	311				
	312				
	313		* 89.2%	6) Sand fl to well (177 to 2000 gr) pebbles (30% 4 to 10 mm thick), poorly sorted, off white (10Y),	
	314		**	any to subang, dk heavy minerals: common, clay (5%)	
				* v. dark rd (10R 2/2) staining, sand, iron oxide staining (3 to 5 mm thick)	
	315			* iron oxidized cemented laminae.	
	316		7)	7) Sand fl to ch (177 to 710 gr), mod to well sorted, off white (10Y) to pale grey (10Y 8/2),	
				subang to subrnd, mica: common to plentiful, dk heavy minerals: common to plentiful	
	317			clay (5%) taffy texture; granules: rare (3 to 4 mm thick)	
	318			alternating laminae (= 3 to 5 mm thick) of clean sand w clayey ^{micaceous} sand mica = 2 mm thick	
	319		319' 5"		
	320				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 17 OF
WELL NO. 66B-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#65 320- 326	320		93%	pebbles (<2% 5 mm thick) 1) Sand, ml to vcl (250 to 1410) mod sorted, off white (W), subang to submed micaceous - mica common to plentiful, drk heavy minerals: common clay (1 to 3%) clay texture some alternating laminae (3 to 4 mm thick) of micaceous sand, clean sand or clay	
	321				
	322				
	323			2) Sand, ml to vcl (350 to 2000) pebbles (3 to 40% 4 to 7 mm thick), poorly to mod sorted, off white (W) to drk yw org (10YR 6/6), subang to submed, drk heavy minerals: common to plentiful, mica: rare to common, clay (5%) thin clay laminae (10%) off white (W) ang to subang	
	324				
	325			3) Clean sand, ml to cl (250 to 710) mod sorted, bedded & 45% w concentration of drk heavy minerals outlining the top + bottom of the laminae = 20 mm thick	
	326		53.5%	4) 20 mm thick iron oxide cemented sand, dusky rd (10R 2/2) staining of sand around cemented zone	
	327			5) Sand, ml to vcl (350 to 2000) pebbles (20% 3 to 5 mm thick), poorly to mod sorted, off white (W) to drk yw org (10YR 6/6), subang, drk heavy minerals: common to plentiful mica: common, clay (5 to 10%) some thin clay laminae (= 2 to 4 mm thick) white (W)	
	328				
	329			6) clay, yw gr (5Y 8/1) micaceous, = 35 mm thick, concentration of drk heavy minerals on top of clay laminae.	
	330		329' 9"		
	331			7) Sand, fl to vcl (1770 to 1900) mod sorted, off white (W), subang to submed micaceous: common to plentiful, drk heavy minerals: common clay laminae = 2 mm (5%)	
	332			*concentration of drk heavy minerals above lithologic change = 4 mm thick	
	333		72.2%		
	334			Sand, ml to vcl (250 to 2000) pebbles (10% 5 to 10 mm thick) mod sorted, off white (W) to drk yw org (10YR 6/6), subang to submed, micaceous: mica: common to plentiful drk heavy minerals: common to plentiful, clay (10%) clay texture numerous thin laminae (= 2 mm thick) of drk heavy minerals	
	335		335' 2"		
	336		78.5%	8) Sand as above, pale rd (5R 4/2)	
	337			9) Sandy clay, v drk yw org (10YR 6/6), dusky rd (10R 2/2) staining of sand c top + bottom of clay	
	338				
	339			10) Sand, ml to vcl (350 to 2000) poorly to mod sorted, ggy purple (5P 4/2), subang, drk heavy minerals: common, mica: common numerous thin clay laminae (= 4 mm thick), off white (W)	
	340			11) described on next sheet	

200' 31"
200' 32"200' 31"
200' 32"200' 31"
200' 32"

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 18 OF
WELL NO. GCB-2		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#67 343-351	340		341.6"	1) Sand fm to cl (1770-1000) med sorted, dk grey org (10YR 6/6), sandy to subbrd, dk heavy minerals: common to plentiful, micaceous mica: common to plentiful, clay (10%) clay texture	
	341			numerous thin clay + dk heavy minerals laminae (= 2 to 4 mm thick)	
	342			clay (10%) clay texture	
	343			pebbles (10%, 5 mm thick)	
	344			1) Sand, ml to vcl (250 to 2000), med sorted, dk grey org (10YR 6/6), sandy to subbrd, dk heavy minerals: common to plentiful, mica: rare to common, clay (5%)	
#70 351-357	345		347.5"	Thin clay laminae, dusky red (10R 3/2) staining, 1 sand below clay laminae ± 20 mm thick @ 343'6"	
	346			clay content increase	
	347			2) Clayey sand, clay (20%) micaceous mica: common to plentiful, clay texture	
	348			* iron oxide staining, dusky red (10R 3/2)	
	349			thin clay laminae ± 10 to 15 mm thick off white (N9), iron oxidized staining above clay, mud brown (5YR 3/4) staining	
#71 358-365	350		83.3%	3) Sand ml to vcl (250 to 1500), med sorted, grey org (10YR 7/4) to dk grey org (10YR 6/6)	
	351			dk heavy minerals: rare, mica: rare to common, clay (5%)	
	352			grades into	
	353			4) clayey sand, ml to vcl (250 to 700), med to well sorted, off white (N9) to pale grey org (10YR 7/4)	
	354			micaceous: common to plentiful, clay (30 to 40%) clay texture	
#71 358-365	355		356.10"	some flakes ± 30 mm in length	
	356			numerous thin laminae of alternating clayey sand & clean sand	
	357			dk heavy minerals: common - some thin laminae thru section	
	358			* iron oxide staining = 355'	
	359			5) Sand ml to vcl (250 to 2000), pebbles (5% 3 mm thick), med sorted, all white (N9) to grey org (10YR 7/4), sandy to subbrd, dk heavy minerals: rare to common	
#71 358-365	360		86.9%	micaceous, clay (5%) grades into	
				* thin laminae ± 2 mm thick dk heavy minerals	

* iron oxide staining, mud brown (5YR 3/4)

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 19 OF
WELL NO. 6413-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	36.0		3)	5) as above	
	36.1		x 2	1) Sand mlt to cl (350 to 710 μ) well sorted, dk heavy org (10YR 4/6), subang	
	36.2		1)	mica: common to plentiful, dk heavy minerals: rare grades into	
	36.3			* iron oxide staining, mod brown (5YR 3/4)	
	36.4		2)	clay content increases	
	36.5		3)	2) clayey sand, flt to mlt (100 to 500 μ) mod to well sorted, v pale org (10YR 8/2) subang to submed	
	36.6		34%	dk heavy minerals: rare mica: common to plentiful clay (30 to 40%) clay texture	
	36.7			numerous thin clay laminae = 5 to 10 mm thick above + iron oxide staining	
	36.8			* iron oxide staining = 15 mm thick $\rightarrow$ some cemented	
	36.9		79%		
	37.0			3) Sand, mlt to cl (250 to 710 μ) well sorted, off white (10Y) to v pale org (10YR 8/2)	
	37.1		3)	ang to subang, dk heavy minerals: common, mica: common to plentiful	
	37.2			* iron oxide staining = 5 mm thick, mod brown (5YR 3/4)	
	37.3				
	37.4			* iron oxide staining of sand = 10 mm thick, mod brown (5YR 3/4) grades into:	
	37.5			1) Sand mlt to silt (250 to 1410 μ , 2000 μ) mod sorted, off white (10Y) to v pale org (10YR 8/2)	
	37.6		37.2-37.3	subang to ang, dk heavy minerals: common to plentiful, mica: common	
	37.7				
	37.8		1) 87.2%	1) Sand, silty, flt to mlt (100 to 500 μ) mod sorted, off white (10Y) grades into:	
	37.9		*	clay (6%) calc texture, mica: common to plentiful	
	38.0			* iron oxide staining (cemented) mod brown (5YR 3/4)	
			2)	2) Sand, mlt to well (350 to 2000 μ) pebbles (5 to 10%, 2 to 5 mm thick) poorly to mod sorted	
				off white (10Y), ang to subang, dk heavy minerals: common mica: common to plentiful	
				numerous thin laminae = 2 to 4 mm thick of iron oxide staining, mod brown (5YR 3/4)	
				* iron oxide staining, mod brown (5YR 3/4) = 3 mm, concentration of dk heavy minerals below laminae	
			3)	3) Clayey sand, mlt to mlt (250 to 500 μ) mod to well sorted, v pale org (10YR 8/2)	
				micaceous: plentiful, clay (30 to 40%) clay texture	
			37.5-37.8	numerous thin grt sand laminae = 2 mm thick (clay) vcll (1410 to 2000 μ) pebbles (5% 3 mm thick)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 20 of
WELL NO. GCB-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#74 370- 386	38.0		88.8%		
	38.1			bluish, silty sand, f. to m. (175 to 500 μ), med. well sorted, off white (5Y) to pale gray (10YR 8/2), subang. to subbrnd, micaceous: plentiful to abundant, clay (20 to 15%), dk heavy minerals: rare	
	38.2				
	38.3			numerous clean gr. sand laminae $\approx$ (2 to 5 mm thick) sand cl. to v. cl. (110 to 2000 μ)	
	38.4			partly sorted, iron oxide staining, gray to purple (5YR 4/3), ang. to subang. dk heavy minerals: common to rare, laminae are $\approx$ 45° to horizontal bedding	
	38.5		88.5%		
#75 386- 393	38.6		100%		
	38.7			Sand, silty, m. to cl. (250 to 1000 μ , 2000 μ) med. sorted, off white (5Y) to pale gray (10YR 8/2)	
	38.8			micaceous: plentiful to abundant, subang. to subbrnd, dk heavy minerals: rare	
	38.9			grades into:	
	39.0				
	39.1		*	* iron oxide staining $\approx$ 1 mm to 2	
	39.2		**	* * iron oxide staining $\approx$ 30 mm thick, med. brown (5YR 4/4)	
	39.3		*	Sand cl. to v. cl. (110 to 2000 μ) med. well sorted, ang. to subang. grades into:	
	39.4			low deposits: pebbles/granules: 10 to 15 mm thick, clay laminae $\approx$ 5 mm, off white	
#76 393- 395	39.5		66.6%	* thin iron oxide laminae $\approx$ 15 mm thick @ top of lag, dusky rd (10R 2/3)	
	39.6			and of run clay, off white to pale gray (10YR 8/2)	
	39.7		39.7%	clay, silty, sandy, mottled, off white (5Y) to dk rd (5YR 3/6)	
#77 395- 402	39.8		72.6%	sandy clay as above, grades into:	
	39.9			$\approx$ 396' Sand m. to cl. (350 to 710 μ) med. sorted, off white (5Y) to yellow gray (5Y 7/2)	
	40.0			subang. to subbrnd, mica: abundant, dk minerals: common	
				interbedded clay laminae rare as above. grades down into	
				$\approx$ 398' sandy, silty clay, yellow gray (5Y 7/2)	
				interbedded sand $\approx$ 398' 6", sand m. to cl. (350 to 710 μ) med. sorted,	
				dk rd brown (10R 3/4), iron oxide staining	
				$\approx$ 399' 7" sharp contact w. sand, m. to cl. (350 to 710 μ) med. well sorted	
				gray to pale (5YR 7/2), subang. to subbrnd, mica: common to abundant	
				dk minerals: common thin clay laminae bottom 6" off white (5Y)	

FIELD GEOLOGIC LOG

PROJECT		LOGGED BY: 6613-2		WELL NO.	
DATE		REFERENCE DATUM		SRP COORDINATES	
SHEET 21 OF		DILLING CONTRACTOR		DILLER	
		DILLING METHOD		COMPANY	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
400	40.0		40%		
401	40.1				
402	40.2		37.5	1) Sand, silty with (35 to 40% silt) poorly sorted, often with (20%) clay to silty clay. mica abundant, minerals common, clay (20%) silty texture.	
403	40.3			2) Iron oxide staining ± hematite, high concentration of chlorite, gray to purple (SRP 1/2).	
404	40.4		40.4%	3) clay, mottled, pale red purple (SRP 1/2) to gray red purple (SRP 1/2).	
405	40.5		7%		
406	40.6			clay, mottled, pale red purple (SRP 1/2) to gray red purple (SRP 1/2) grades into well-indurated.	
407	40.7			from 40.6.5 to 40.7.7' clay, mottled, mod red (SRP 1/2) to mod red (SRP 1/2) silty texture to : silty texture.	
408	40.8			c 40.7' clay, mottled, gray (SRP 1/2) to mod light gray (SRP 1/2) grades into	
409	40.9				
410	41.0			clay, mottled, light gray (SRP 1/2) to mod light gray (SRP 1/2), well-indurated.	
411	41.1				
412	41.2				
413	41.3		41.3%		
414	41.4		97%		
415	41.5			clay, mottled, mod light gray (SRP 1/2) to mod light gray (SRP 1/2), light olive brown (SRP 1/2), mica common, well-indurated, grades into:	
416	41.6				
417	41.7				
418	41.8				
419	41.9		41.9%	c 41.8' clay, mottled, mod red (SRP 1/2) to gray red (SRP 1/2) well-indurated.	
421	42.1		100%	clay, mottled, mod red (SRP 1/2) to gray red (SRP 1/2) silty texture to : silty texture.	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 22 OF		
REFERENCE DATUM		DRILLING CONTRACTOR			
SRP COORDINATES		DRILLER			
COMPANY		DRILLING METHOD			
WELL NO. 6B-2					
LOGGED BY: 1					
RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
420				c 420.2' clay, mottled w/ iron oxide staining & cementation, undulating purple (SRP 3/2) to bluish white (SRP 1/1)	
421			76.6%	* iron oxide staining = 3cm thick, undulating purple (SRP 3/2)	
422				Sand, flint (125 to 350 μ) med to well sorted, off white (SRP 1/1) clay, micaceous, mica abundant	
423				all minerals: common, clay recess	
424					
425			425.10"		
426			91.6%	1) Sand, flint (125 to 350 μ) well sorted, off white (SRP 1/1) submed to med, mica: abundant all minerals: rare to common grades into: * iron oxide staining = 7mm thick, purple (SRP 1/1)	
427					
428					
429					
430				Sand, flint (177 to 710 μ 1/4) med sorted, off white (SRP 1/1) to gray (SRP 7/4), submed to med, all minerals: common to plentiful, mica: rare to common	
431					
432			432.5"		
433			71.9%	3) Sand, micro vel (350 to 2000 μ) pebbles (2 to 5% 3 to 7mm thick) poorly to med sorted, off white (SRP 1/1) to gray (SRP 7/4) submed to med, all minerals: common to plentiful, mica: common grades into: c 434.5' sand, all to vel (710 to 2000 μ) pebbles (10 to 15%, 3 to 7mm thick) poorly sorted, submed * iron oxide staining = 2.5 cm thick, med brown (SRP 3/4)	
434					
435					
436				4) Sand, flint (177 to 1000 μ) med to med sorted, off white (SRP 1/1) submed, mica: plentiful, all minerals: common clay (SRP 1/1) grades into:	
437				c 436.5' sandy flint to vel (177 to 2000 μ) pebbles (5% 3 to 7mm thick) and sorted, off white (SRP 1/1) submed to submed, mica: plentiful, all minerals: common, clay (SRP 1/1)	
438					
439					
440					

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 23 OF
WELL NO. 6613-2		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#85 440- 447	440		92.8%	1) Sand, ml to vel (350 to 2000) poorly sorted, off white (W) to pale gray (10Y 7/2) subang, mica: plentiful, dhminerals: common grades into:	
	441		1)	some thin laminae $\approx$ 2 to 5 mm thick, clayey sand & pebble sand (3 to 7 mm thick) and	
	442			* iron oxide staining $\approx$ 10 mm thick, gray red purple (5RP 4/6) to velvety rd purple (5RP 3/2)	
	443		*	2) Sand, ml to vel (350 to 2000) pebbles (5% to 3 to 7 mm thick) poorly sorted, off white (W) to	
	444		2)	pale gray (10Y 7/2) subang, mica: plentiful, dhminerals: common, grades into:	
	445		*)	* iron oxide staining, $\approx$ 2 mm thick, pebble core, (20% to 3 to 10 mm thick) and	
	446		3)	3) Sand, ml to vel (250 to 1000 or 1410) mod sorted, off white (W) to pale gray (10Y 7/2)	
	447		44.6"	ang to subang, mica: plentiful, dhminerals: rare to common	
#86 447- 453	447		94.4%		
	448				
	449			Sand, ml to vel (250 to 710 or 1000) mod sorted, off white (W), subang, mica: common,	
	450			dhminerals: common	
	451				
	452				
	453		452.8"	1) Sand, ml to vel (350 to 1410) pebbles (5 to 10%), 3 to 5 mm thick, poorly sorted, off white (W) to	
	454		92.8%	pale gray (10Y 7/2), ang to subang, mica: plentiful, dhminerals: common	
	455		1)	* iron oxide staining $\approx$ 3 mm thick, some cementation, mod brown (5YR 3/4) to velvety rd (10R 3/4)	
	456		2)	2) Sand, ml to vel (350 to 2000) pebbles (10 to 15%), 3 to 7 mm thick, poorly sorted, off white (W)	
	457		*)	subang to submod, mica: plentiful, dhminerals: rare to common	
	458		*)	* iron oxide staining $\approx$ 10 mm thick, drk rd brown (10R 3/4) to velvety rd (10R 3/2)	
	459		1)	3) Sand, ml to vel (250 to 500 or) well sorted, off white (W), submod to mod, mica: abundant,	
	460		459.6"	dhminerals: common, grades into:	
				c 457.5' sand, ml to vel (250 to 1410) pebbles (10 to 15%), 2 to 5 mm thick, poorly sorted	
				off white (W) to pale gray (10Y 7/2), subang, mica: abundant, dhminerals: common	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 24 OF
WELL NO. 6CB-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#88 460-464	46.0		66.6%	1) Sand, fl to fl (125 to 250) well sorted, pale gray (10Y 8/2), ang, mica: abundant, dh minerals: common.	
	46.1			* iron oxide staining = 7mm thick, dark red brown (10R 3/4)	
	46.2			2) Sand, micro vcl (350 to 2000) pebbles (5 to 10%), 2 to 5mm thick, poorly sorted, off white (10Y 9/2), subang to subord, mica: abundant, dh minerals: common	
	46.3		46.28"	3) clay, gray (5Y 8/1) = 8mm thick	
	46.4			4) Sand, micro vcl (250 to 1410) poorly to med sorted, off white (10Y 9/2) to pale gray (10Y 8/2), ang to subang, mica: abundant, clay (5%) clay texture	
#89 464-471	46.5		65.4%	Sand, micro cl (250 to 1000 or 1410) med sorted, off white (10Y 9/2), ang to subang, mica: abundant, clay (2%) grades into:	
	46.6				
	46.7				
	46.8			c. 467.5' Sand, ch to vcl (500 to 2000) pebbles (10%, 2 to 5mm thick), poorly to med sorted, off white (10Y 9/2), ang to subang, mica: abundant, grades into:	
	46.9		46.84"	c. 468.3' Sand, micro cl (350 to 1410), well sorted, ang to subang	
	47.0				
#90 471-475	47.1		75%	5) Sand, micro cl (250 to 910) well sorted, off white (10Y 9/2), ang to subang, dh minerals: plentiful, mica: common	
	47.2			* iron oxide staining = 7mm thick, pale red purple (5R 4/2)	
	47.3			6) Sand, fine cl (910 to 710 or 1410) med to well sorted, subang to subord, dh minerals: plentiful	
	47.4		47.4"	* iron oxide staining = 3mm thick, gray red purple (5R 4/2) to dusky red purple (5R 3/2)	
	47.5			7) Sand, micro cl (350 to 1000 or 1410) med to well sorted, gray red purple (5R 4/2) to pale pink (5R 6/2), subang to subord	
#91 475-477	47.6		71.6%	clay, mottled, gray (5Y 8/1) to med rd (5R 5/4), gray pink (5YR 7/2)	
	47.7		47.610"		
#92 477-480	47.8		66.6%	clay, mottled, gray pink (5YR 7/2) to med rd (5R 5/4) grades into:	
	47.9		47.7"	c. 478.5' silty/sandy clay, pale gray (10YR 8/2) sand, vcl to fl (85-177) well sorted, ang, mica: abundant	
	48.0				

FIELD GEOLOGIC LOG

PROJECT		DATE 6-21-76	SHEET 25 OF
WELL NO. 6613-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#73 480- 485	480		61.6%	Sand, fl to mh (125 to 350 ϕ) well sorted, ggy (5Y 6/4) to pale ggy (10Y 8/2), congl.	
	481			mica: abundant	
	482			* iron oxide cemented $\approx$ 3 mm thick, mod brown (5YR 5/4)	
	483		483.1"	Sand, mh to uck (350 to 1410 ϕ) mod sorted, subang to subrnd, mica: abundant grades into	
	484			C 482.3' Sand, sh to ucl (500 to 8000 ϕ) pebbles (5% 3 to 4 mm thick) mod sorted, subang,	
	485			mica: abundant, sh minerals: common to plentiful	
#74 485- 492	486		88%	1) Sand mh to ucl (250 to 2000 ϕ) pebbles (10 to 15%, 5 to 10 mm thick) mod sorted,	
	487			off white (10Y) w streaks of udk rd (5R 2/6), subang to subrnd, dk heavy minerals: common	
	488			mica: rare, clay (5%) grades down into:	
	489			2) Sand fl to cl (100 to 6000 ϕ) pebbles (< 2% 5 mm thick) mod to well sorted, off white (10Y),	
	490			u dk rd (5R 2/6), ggy org (10YR 7/4), subrnd, mica: common to plentiful, dk	
	491			heavy minerals: rare to common clay (20 to 25%)	
	492			3) Udky red (10R 2/2) staining of sand, iron oxide staining, high concentration of pebbles $\approx$ (5 to 10 mm thick)	
	493			in these zones,	
#75 492- 495.6"	494		100%	4) Sand mh to ucl (250 to 2000 ϕ) mod sorted, off white (10Y), subang to subrnd	
	495			mica: common to plentiful, dk heavy minerals: rare to common clay (10%) to clay residue	
#76 495.6- 498"	496		98.1%	5) 492.6" 10 mm thick laminae of udky red (10R 2/6) staining of sand iron oxide staining	
	497			6) sandy clay, mottled, ggy (5Y 7/2) w udk rd (5R 2/6), sand (5 to 10 ϕ) cl to ucl (710 to 1410 ϕ) subang	
	498			7) clay sand, mottled, udky (5Y 7/2), udk rd (5R 2/6), pale rd (5R 6/2)	
	499			sand (50 to 60 ϕ), mh to ucl (250 to 1300 ϕ) subang to subrnd	
#77 498- 501"	500		55.5%	clayey sand mh to ucl (250 to 2000 ϕ) poorly mod sorted, mottled, udky (5Y 7/2) w	
			497.8"	pale rd (5R 6/2), mica: rare, clay (20 to 25%)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 26 OF
WELL NO. GCB-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#98 501'- 508'	500				
	501		100%	1) same as above clay sand grades down into: = 502 clay content increases	
	502				
	503			2) silty clay mottled, yellow (5Y 7/2), pale rd (5R 6/2), sand (5% or less) cl (500 to 710+) subang dark heavy minerals: rare	
	504				
	505				
	506				
	507				
#99 508'- 509'- 510'- 513'	508		100%	silty clay as above	
	509				
	510		31.8%	3) silty clay mottled, yellow (5Y 7/2), pale rd (5R 6/2), mica: rare to common, dark heavy minerals: rare to common grades down into: lots sand increases. ↓ F = 511'	
	511				
	512		512' 4"	4) Sandy clay mottled, yellow (5Y 7/2), pale rd (5R 6/2), sand (20%) mlt to ucll (250 to 2000+) subang dark heavy minerals: rare, mica: rare	
#101 513'- 517'	513		68.7%		
	514		51	5) Sand mlt to ucll (250 to 2000+) mottled, dk gw org (10YR 6/2), subang to subrd dark heavy minerals: rare to common, clay (<1%)	
	515		515' 4"	6) Clayey sand, yellow (5Y 7/2)	
	516			7) Sand, mlt to ucll (250 to 2000+) pebbles (10% 4 to 7 mm thick) mod sorted off white (N9) to dk gw org (10YR 6/2), subang to subrd, clay (<2%)	
#102 517'- 521'	517		31.2%		
	518		518' 3"	sandy clay, pale yellow brown (10YR 6/2), sand (5-10%) mlt to ucll (250 to 1000+) subang	
	519				
	520				

PROJECT	DATE	SHEET
		27 OF
REFERENCE DATUM	DRILLING CONTRACTOR	
WELL NO. 6CB-2	SRP COORDINATES	DRILLER
LOGGED BY	COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#102A 521- 523	520				
	521		" 37.5%	1) clay, off white (1Y)	
	522		521'9"	2) Sand ml to ucl (250 to 8000+) partly to med sorted, off white (1Y) to dk grey org (10YR 6/6) dk heavy minerals rare mica rare, clay (<1%)	
#103 523- 532	523				
	524				
	525		0%		
	526			No Recovery	
	527				
	528				
	529				
	530				
	531				
#104 532- 535	532		86.1%		
	533	*		Sand f1A to ucl (200 to 2000+) pebbles (10% 5 mm thick) mostly round sorted, off white (1Y) to grn org (10YR 7/4), dk heavy minerals: rare to common mica rare, clay (<1%)	
	534		534'7"	* v dusky rd (10R 2/2) staining of sand, iron oxide staining = 5 mm thick	
#105 535- 541	535		43%	1) Sand ml to ucl (250 to 2000+) pebbles (5 to 10% 3 to 5 mm thick) partly m med sorted, off white (1Y) to mod pnk (5R 7/4), dk heavy minerals: common to plentiful	
	536				
	537		537'9"	2) Sandy clay, grn org pnk (5YR 7/2), sand ml to cl (250 to 700+) subang resubred	
	538			3) Sand ml to cl (350 to 1000+) med to well sorted, off white (1Y) subred, dk heavy minerals: common grades down into	
	539			sand ↑ increase in size → ml to ucl (250 to 2000+) pebbles (7% 3 to 5 mm thick)	
	540			* A v dusky rd (10R 2/2) staining of sand, iron oxide staining = 15 mm thick	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 28 OF
WELL NO. GC13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#106 541-545	540				
	541		1) 83.3%	1) Sandy clay, gray to pink (5YR 7/2) sand, mlt to well (850 to 2000+) subbed to subang	
	542		3) 2)	+ v. dusky rd (10R 3/2) staining of sand, iron oxide staining = 3 to 5 mm thick, pebbles (5 mm thick) and concentration of drk heavy minerals in this zone	
	543			2) Sand f. to m. (177 to 550+) med sorted, off white (N9) to pale gray (10YR 8/6), subang	
	544		3) 54' 4"	drk heavy minerals: common to plentiful	
#107 545-552	545		4) 85.7%	3) Sand, mlt to well (850 to 2000+) pebbles (30% 2 to 4 mm thick) subang, off white (N9) to pale gray (10YR 8/6), drk heavy minerals: common to plentiful - some laminae	
	546		5)	4) Sand mlt to well (350 to 2000+) pebbles (10 to 20% 4 to 7 mm thick) partly to med sorted	
	547		4)	gray to (10YR 7/4), subang to subbed, drk heavy minerals: common	
	548			+ iron oxide staining, laminae = 10 mm thick, v. dusky rd (10R 3/2) at base of this zone	
	549		6)	5) Sand f. to c. (177 to 1000+) med to well sorted, off white (N9) to pale gray (10YR 8/6), subang	
	550			drk heavy minerals: common mica: rare clay (10 to 15%)	
	551		55'	6) Sand, ch to c. (500 to 1000+ 1410+) med to well sorted, off white (N9) to pale gray (10YR 8/6)	
	552			subang to subbed, drk heavy minerals: common, mica: common, clay (5%)	
#108 552-559	552		96.6%	alternating micaceous sand w/ clean sand w/ clayey sand	
	553		7)	7) Sand f. to c. (177 to 1000+) med sorted, off white (N9), subang to subbed	
	554			drk heavy minerals: common clay (10%)	
	555		8)	thin laminae (= 2 mm thick) of drk heavy minerals + clay	
	556		9)	pebbles (25% 4 to 7 mm thick)	
	557		55' 10"	8) Sand mlt to well (250 to 2000+) partly sorted, off white (N9) to gray (10YR 7/4), subang to subbed	
	558		60%	drk heavy minerals: common	
	559		10)	9) Sand f. to m. (177 to 500+ 710+) med to well sorted, off white (N9), subang to subbed	
#109 559-562	559		11)	mica: common to plentiful drk heavy minerals: common clay (20%) sandy texture	
	560		560	11) Same as above	
				12) Sand mlt to well (250 to 2000+) granules (20% 5 mm thick) partly sorted, off white (N9)	
				drk heavy minerals: plentiful to abundant → high concentration of iron oxide staining	
				+ iron oxide staining of sand = 25 mm thick, v. dusky rd (10R 3/2)	
				11) Sand f. to m. (Same as above #9) alternating laminae = 2 mm thick of clean sand w/ clayey sand	
				12) = 30 mm thick laminae of granules = 1 to 2 mm thick, well sorted, high concentration of drk heavy minerals	

PROJECT	WELL NO.	LOGGED BY	COMPANY	DRAWING METHOD
DATE	REFERENCE DATA	SPP COORDINATES	DRAWER	SHEET
DRILLING CONTRACTOR				OF

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
560					
561					
562					
563					
564					
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580					

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 30 of
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. GC13-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#116 580-586	580		73.8%	1) Sand, fll to well (177 to 2000+) pebbles (25 to 30% 4 to 7 mm thick) mostly round sorted, off white (W9), dk heavy minerals: common, clay (5%) grades down into	
	581				
	582			2) Sand, ml to well (350 to 2000+) not sorted, off white (W9) to mod red (5R 5/4), subang to subround numerous clay laminae = 1 mm thick, clay (25%) grades into	
	583			some as #2, iron oxide staining of sand = 583'6" based well sand, v. dark red (10R 3/2)	
	584		584'5"	3) Sand, ml to well (250 to 500+) well sorted, off white, subang to subround	
	585				
#117 586-592	586		* 591.7%	4) Silty sand, ml to well (250 to 2000+) pebbles (5 to 10%, 5 to 10 mm thick) ang to subang, grey org (10YR 7/4), dk heavy minerals: common	
	587			Thin clay laminae = 1 mm thick, off white (W9)	
	588			* iron oxide staining of sand = 2.5 mm thick, v. dark red (10R 3/2)	
	589		591.7"	5) Clayey Sand, ml to well (350 to 2000+) pebbles (25% 7 to 10 mm thick) off white (W9) to pale red purple (5R 6/2), subang to subround, dk heavy minerals: common to plentiful clay (15 to 20%)	
	590				
	591				
#118 592-595	592		36.1%	6) Sand, ml to well (250 to 1410+) subang, off white (W9), not sorted, dk heavy minerals: rare to common	
	593		593'1"	7) pebble bed = 20 mm thick, subround to round * Top of Cape Fear *	
	594			8) Sandy clay, mottled, pale red (10R 6/2) to grey org pink (5YR 7/2)	
	595		0%	No Recovery	
#119 595-596"	596		61.1%	Sandstone, grt conglomerate, Sand, ml to well (250 to 1410 or 2000+) pebbles 25% up to 10 mm then = 20 to 25%, 5 to 10 mm thick, partly to mod sorted, off white (W9) to pale org (10YR 8/2) w grey red purple (5R 4/2), granules - ang, sand - subang	
#120 596-597	597		596'5"		
	598		50%	same as above, but granules = 597'3" pebbles = 10 mm, subang	
#121 597-600	599		598'6"		
	600				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 31 OF
WELL NO. 6C13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#122 600'- 608'	60.0		59.5%	1) Sandstone, qtz conglomerate, sand mtl to well (350 to 2000+) pebbles (25 to 35%, 5 to 10 mm thick) submed	
	60.1			all white (119) to iron oxide staining gray red purple (SRP 1/2)	
	60.2		100%	alternating sequences of coarse grain in the stained zones to fine grain in the all white (119) zone	
	60.3			* high concentration of pebbles ≈ 10 mm thick + iron oxide staining above contact w/ clayey sand below	
	60.4		27.7%	2) clayey sand/sandy clay, sand mtl to ch (250 to 710+) well sorted, all white (119) to pale red purple (SRP 6/2)	
#123 603'- 605'	60.4		60.7%	3) sand	
#124 605'- 607'	60.5		100%	Thin iron oxide cemented laminae ≈ 4 mm thick on top of clay below, sand mtl to ch (250 to 710+ 1200+) poorly to med sorted, velvety red purple (SRP 3/2) clay, pale pink (SRP 8/2)	
	60.6			3) silty clay, sand, pale pink (SRP 8/2), sand (<2%) ch (710 to 1000+) subang to submed	
	60.7		68.7%	* Bottom of Cape Fear *	
#125 607'- 611'	60.7			4) silty sandstone (siltstone) fl (125 to 177+) well sorted, all white (119), submed	
	60.8			5) sandy clay, all white (119) sand, mtl to ch (350 to 1410+ 2000+) pebbles (10 to 15% 1/4 to 7 mm thick)	
	60.9			poorly sorted, subang to submed some zones are semi consolidated grades into:	
	61.0		60.9%	6) sand clay, sand mtl (150 to 350+) well sorted, subang to submed grades into:	
#126 611'- 615'	61.1		20.8%	7) sand clay/clayey sand, sand mtl to well (1000 to 2000+) med to well sorted, subang	
	61.2				
	61.3				
	61.4		61.4%	dense silty clay, light gray (128) to med light gray (126) grades into sandstone, sand mtl (88 to 125+) well sorted, submed	
#127 615'- 616'	61.5		100%	numerous veins filled w/ clay siltstone (123), abraded surface ≈ 615.6 (secondary) well rounded edges	
#128 616'- 618'	61.6		61.5%	some structure $\rightarrow$ clean sand showing bedding	
	61.7		20.8%	sandstone as described above	
	61.8			Sandstone fl (125 to 177+) well sorted, gray (578/1), subang to ang, mica rare to common	
#129 618'- 620'	61.9		0%	dark heavy mineral: common	
	62.0			No Recovery	

PROJECT	WELL NO.	LOGGED BY	COMPANY	DRILLING METHOD
DATE	REFERENCE DATUM	SAP COORDINATES	DRILLER	DRILLING CONTRACTOR
SHEET	32	OF		

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
640	639				
638	637				
636	635				
635	634				
634	633				
633	632				
632	631				
631	630				
630	629				
629	628				
628	627				
627	626				
626	625				
625	624				
624	623				
623	622				
622	621				
621	620				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 33 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. GCB-2	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#135 640'- 645'	64.0		88.3% 640' 7"	lg grt clast (10 to 30 mm thick) top 5 cm of run	
	64.1			Sandy clay, med light grn (10G), sand ml to med (850 to 1410 + 2000+), pebbles, (25% 4 to 7 mm thick)	
	64.2			poorly cemented, subang to submed, mica: common, dk heavy minerals: rare	
	64.3
	64.4			clay, mottled, light grn (10G), pale rd (5R 4 1/2), med rd (5R 4 1/2), dk rd (5R 3 1/4), light olive brown (5Y 5 1/6)	
	64.5			mica: common	
#136 645'- 648'	64.6		100%	clay, mottled same as above: grades into:	
	64.7			clay, pale green (10G 6 1/2) = 647' grt pebble lag = 30 mm thick, grt = 10 to 20 mm thick, subang to submed	
	64.8			clay, mottled, same as above	* Saponite
#137 648'- 651'	64.9		100%	* Triassic * Saponite	
	65.0			clay, mottled, very dense, grn (5G 7 1/2), med rd (5R 4 1/2), dk rd brown (10R 3 1/4)	
	65.1			numerous iron stained clasts (clay med rd (5R 4 1/2) to dk rd brown (10R 3 1/4) = 2 to 10 cm in diam)	
#138 651'- 655'	65.2		100%		
	65.3			Dense clay, mottled w absts some foliation, sandy to clay texture	
	65.4			med rd brown (10R 4 1/2), dk rd brown (10R 3 1/4), med grn (5G 7 1/2), dk grn (5G 5 1/2), pale grn (5G 6 1/2)	
#139 655'- 659'	65.5		100%	med Saponite contact = 655' above contact grn (5Y 8/1)	
	65.6			Dense clay, massive foliation, thin grt veins = 2 mm thick, grt pebbles above	
#140 659'- 660'	65.7		88.8%	contact, grn olive grn (5G 7 3/2)	
	65.8			Dense clay, heavily foliated, grt olive grn (5G 7 3/2), light olive brown (5Y 5 1/6)	
	65.9			grn (5G 5 1/2), dk grn (5G 4 1/2)	
	66.0		659' 8"	(epidote)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 34 of
WELL NO. 6C13-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#141 665- 665	660		100%	large pebbles at top 5cm, ≈ 60 to 80 mm thick bed rx v. purp	
	661				
	662			dense clay, foliated, same as above	
	663			highly weathered from 661 to 665 loose clay (saprolite)	
	664				
#142 665- 671	665		93%	1) clay saprolite, foliated, highly weathered, grey olive green (5GY 3/2)	
	666			(5Y 3/2)	
	667			divergent clay/mud c $\approx 666'6"$ highly weathered, clay saprolite, grey olive green (5GY 3/2)	
	668			increase in strength of clay	
	669			2) clay, saprolite / chloritic schist	
	670			3) chloritic schist, grey arg (10GY 5/2) $\rightarrow$ dusky arg (5G 3/2)	
	671			some qtz veins $\rightarrow$ iron oxide staining	
	672			some fractures are highly weathered	
#143 671- 673	671		100%		
	672			chloritic schist, as above, small veins ≈ 1 mm thick of qtz throughout	
#144 673- 675	673		100%		
	674			qtz vein ≈ 5 mm thick	
#145 675- 676	675			chloritic schist	
	676				
	677		100%	qtz vein, ≈ 40 mm thick	
	678			chloritic schist	
	679				
	680				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 35 OF
WELL NO. GCB-2		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#147	680		100%	Chloritic Schist, dark grey (65%+) highly fractured	
	681			weathered, or along fractures	
	682				
	683		100%	Chloritic Schist? very hard small fractures	
	684			TD = 684 ft	
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Core-Hole: # GCB-3

7-1-96

Rotary down to 11'10"

		<u>Recovered</u>	
Run 1	11'10"-15'	100%	
Run 2	15-18	2'3"	15-17'3"
Run 3	18-25'	5'9"	18-23'9"
Run 4	25-31	4'6"	25-29'6"
Run 5	31-35	3'8"	31-34'8"
Run 6	35-40	2'6"	35-37'6"
Run 7	40-45	4'11"	40-44'11"
Run 8	45-46	100%	
Run 9	46-46.3	.25	46-46.25
Run 10	46.3-47.3	.65	46.3-46.95
Run 11	47.3-49	100%	
Run 12	49-49.3	.2	49-49.2
Run 13	49.3-52	1.2	49.3-50.5
Run 14	52-55	1.7	52-53.7
Run 15	55-59	3.9	55-58.9
Run 16	59-65	5.4	59-64.4
Run 17	65-72	6.1	65-71.1
Run 18	72-79	6.4	72-78.4
Run 19	79-83	3.4	79-82.4
Run 20	83-87	3.5	83-86.5
Run 21	87-89	1.6	87-88.6
Run 22	89-90	.4	89-89.4
Run 23	90-93	100%	
Run 24	93-99	100%	
Run 25	99-102	1.2	99-100.2

7-2-96

Run 26	102-105	100%	
Run 27	105-108	2'	105-107
Run 28	108-112	.7	108-108.7
Run 29	112-115	2	112-114
Run 30	115-116	no recovery	
Run 31	116-118	1.7	116-117.7
Run 32	118-120	.5	118-118.5
Run 33	120-123	1.4	120-121.4
Run 34	123-124	no recovery	
Run 35	124-126	1.4	124-125.4
Run 36	126-126.5	.3	126-126.3
Run 37	126.5-128	.9	126-127.4
Run 38	128-131	2	128-130

		<u>Recovered</u>	
Run 39	131-134	2	131-133
Run 40	134-138	100%	
Run 41	138-143	4.6	138-142.6
Run 42	143-148	4.8	143-147.8
Run 43	148-153	100%	
Run 44	153-155	1.5	153-154.5
Run 45	155-158	100%	
Run 45a	158-160	100%	
Run 46	160-164	100%	
Run 47	164-169	4.6	164-168.6
Run 48	169-173	no recovery	
Run 49	173-176	100%	
Run 50	176-180	3.8	176-179.8
Run 51	180-185	100%	
Run 52	185-192	5.9	185-190.9
Run 53	192-197	4.7	192-196.7
Run 54	197-202	100%	
Run 55	202-206	100%	
Run 56	206-213	100%	

7-11-96

Run 57	213-217	3.3	213-216.3
Run 58	217-220	100%	
Run 59	220-225	4.8	220-224.8
Run 60	225-232	6.3	225-231.3
Run 61	232-237	100%	
Run 62	237-245	100%	
Run 63	245-253	100%	
Run 64	253-258	100%	
Run 65	258-265	6.7	258-264.7
Run 66	265-273	7.8	265-272.8
Run 67	273-275	no recovery	
Run 68	275-276	no recovery	
Run 69	276-280	3.8	276-279.8
Run 70	280-285	4.9	280-284.9
Run 71	285-287	1.7	285-286.7
Run 72	287-292	4.5	287-291.5

7-13-96

Run 73	292-295	100%	
Run 74	295-300	3.8	295-298.8
Run 75	300-303	1.3	300-301.3
Run 76	303-306	1.7	303-304.7
Run 77	306-309	100%	

		<u>Recovered</u>	
Run 78	309-310	.5	309-309.5
Run 79	310-312	.3	310-310.3
Run 80	312-315	2.8	312-314.8
Run 81	315-319	3.6	315-318.6
Run 82	319-320	.3	319-319.3
Run 83	320-324	100%	
Run 84	324-331	6.2	324-330.2
Run 85	331-334	2.8	331-333.8
Run 86	334-337	2.9	334-336.9
Run 87	337-341	3.6	337-340.6
Run 88	341-346	4.9	341-345.9
Run 89	346-353	6.8	346-352.8

7-14-96

Run 90	353-358	4	353-357
Run 91	358-361	2.2	258-260.2
Run 92	361-363	1.7	361-362.7
Run 93	363-365	100%	
Run 94	365-372	6.4	365-371.4
Run 95	372-376	2.6	372-374.6
Run 96	376-380	3.3	376-379.3
Run 97	380-383	2.1	380-382.1
Run 98	383-387	3.7	383-386.7
Run 99	387-388	no recovery	
Run 100	388-392	no recovery	
Run 101	392-392.7	100%	
Run 102	392.7-395	1.5	392.7-394.2
Run 103	395-399	1.6	395-396.6
Run 104	399-401	1.9	399-400.9
Run 105	401-404	2.9	401-403.9
Run 106	404-407	100%	
Run 107	407-408	.4	407-407.4
Run 108	408-411.2	1.5	408-409.5

7-15-96

Run 109	411.2-411.5	100%	
Run 110	411.5-412.5	100%	
Run 111	412.5-416	3.2	412.5-415.7
Run 112	416-420	3.7	416-419.7

7-16-96

Run 113	420-425	2.6	420-422.6
Run 114	425-427	1.7	425-426.7
Run 115	427-430	2	427-429

		<u>Recovered</u>	
Run 116	430-433	2.9	430-432.9
Run 117	433-436	2.4	433-435.4
Run 118	436-438	1.6	436-437.6
Run 119	438-441	2.5	438-440.5
Run 120	441-445	3.6	441-444.6
Run 121	445-449	2.6	445-447.6
Run 122	449-453	1.1	449-450.1
Run 123	453-455	1.6	453-454.6
Run 124	455-458	2.5	455-457.5
Run 125	458-461	1.7	458-459.7
Run 126	461-464	2.3	461-463.3
Run 127	464-469	3.5	464-467.5
Run 128	469-473	3.3	469-472.3
Run 129	473-476	2.1	473-475.1
Run 130	476-480	3.2	476-479.2
Run 131	480-485	3.7	480-483.7
Run 132	485-485.4	100%	
Run 133	485.4-492	4.7	485.4-490.1

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Run 134	492-493.2	.8	492-492.8
Run 135	493.2-495	.2	493.2-493.4
Run 136	495-498	2.6	495-497.6
Run 137	498-499.5	1.4	498-499.4
Run 138	499.5-503	2.8	499.5-502.3
Run 139	503-503.5	.2	503-503.2
Run 140	503.5-505	.3	503.5-503.8
Run 141	505-509	no recovery	
Run 142	509-511	1.3	509-510.3
Run 143	511-512	.5	511-511.5
Run 144	512-515	2.5	512-514.5
Run 145	515-519	2.5	515-517.5
Run 146	519-523	3.8	519-522.8
Run 147	523-527	3.2	523-526.2
Run 148	527-532	4.2	527-531.2
Run 149	532-536	2.9	532-534.9
Run 150	536-540	3.1	536-539.1
Run 151	540-542	1.2	540-541.2
Run 152	542-547	3	542-545

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Run 153	547-552.5	4.5	547-551.5
Run 154	552.5-558	4.2	552.5-556.7
Run 155	558-560	.6	558-558.6

		<u>Recovered</u>	
Run 156	560-566	3.6	560-563.6
Run 156a	566-572	4.3	566-570.3
Run 157	572-576	2.4	572-574.4
Run 158	576-585	no recovery	
Run 159	585-589	3.9	585-588.9
Run 160	589-592	2.2	Lost 590.2-591
Run 161	592-595	100%	
Run 162	595-597.8	2.5	595-597.5
Run 163	597.8-601	100%	
Run 164	601-606	4.9	601-605.9
Run 165	606-612	5.9	606-611.9
Run 165a	612-616.3	100%	
Run 165b	616.3-620	100%	
Run 166	620-621	100%	
Run 167	621-628	6.6	621-627.6
Run 168	628-631	100%	

7-22-96

Run 169	631-631.9	.6	631-631.6
Run 170	631.9-632	100%	

TD= 632'

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 1 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR USGS-WRI
LOGGED BY Kevin J Conken		SRP COORDINATES	DRILLER Todd Hunter
		COMPANY USGS-WRI	DRILLING METHOD Wire line core

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	0				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
#1 11'10"-15'	12		100%	1) Sand mlt to silt (350 to 2000 μ), med sorted, iron oxide staining, mod rd brown (10R 4/6), subang to subang, dk heavy minerals: rare to common, clay (5%) grades into:	
	13		2	2) Sand sl to mlt (500 to 2000 μ) pebbles (20% 4 to 7mm) poorly to med sorted, iron oxide staining, mod rd brown (10R 4/6) subang to subang, dk heavy minerals: rare to common, clay (5%) grades back into: 1)	
#2 15'-18'	14				
	15				
	16			Sand, mlt to cl (350 to 1000 μ) med sorted, iron oxide staining, mod rd brown (10R 4/6), ang to subang, dk heavy minerals: common, clay (5%)	
	17		17.3"		
#3 18'-25'	18				
	19		3)	3) Sand mlt to silt (250 to 1410 μ) med sorted, iron oxide staining, mod rd brown (10R 4/6), ang to subang, dk heavy minerals: rare, clay (2%) grades into:	
	20		*	* iron oxide staining laminae $\approx$ 10mm thick, dk heavy minerals (25% common, plentiful) mod to med (5R 4/4)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 2 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO.	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	2.0		③	③ described as above grades into:	
	2.1		①	1) Sand fl to cl (177 to 1000 ft) mod sorted, any to subang. grades into:	
	2.2		③	* iron oxide staining laminae ≈ 10 mm thick, u. dusky rd (10R 3/2)	
	2.3		⑤	2) Sand ml to cl (250 to 1000 ft) mod sorted, light brown (5YR 5/6), any to subang, dk heavy minerals: common	
	2.4		23' 9"	3) alternating laminae of clay sand fl (177 to 250 ft) well sorted, gray org (10YR 7/4) to pale yellow (10YR 8/6) any, dk heavy minerals: common, mica: common, clay (15%)	
	2.5		④	④ clean sand, ml to cl (350 to 710 ft) well sorted, dk gray org (10YR 6/6), any, dk minerals: common	
	2.6		④	4) clean sand, cl to ucl (710 to 2000 ft) pebbles (2 to 5% 2 to 5 mm thick) well sorted, dk gray (10YR 6/6) any, dk minerals: common grades into:	
	2.7		⑤	5) sand, ml to ucl (250 to 2000 ft) pebbles (2 to 5% 3 to 7 mm thick), poorly to mod sorted, light brown (5YR 5/6) any to subang, dk minerals: common	
	2.8		⑥	* iron oxide cemented laminae ≈ 10 mm thick, u. dusky rd (10R 3/2) * iron oxide staining laminae ≈ 5 mm thick, u. dusky rd (10R 3/2)	
	2.9		④	6) clean sand, ml to ucl (350 to 1410 ft, 2000 ft) mod sorted, dk gray (10YR 6/6), any to subang	
	3.0		27' 6"		
	3.1				
	3.2		⑦	7) Sand, fl to ml (177 to 350 ft, 500 ft) well sorted, dk gray org (10YR 6/6), any to subang, dk minerals: common mica: common, numerous thin clay laminae ≈ 2 mm thick, u. pale org (10YR 8/2)	
	3.3		⑧	8) clay laminae ≈ 15 mm thick, dk gray (10YR 6/6)	
	3.4		⑨	9) Sand ml to cl (250 to 1000 ft) mod sorted, dk gray (10YR 6/6), any to subang, mica: common, dk minerals: rare to common	
	3.5		34' 8"		
	3.6		⑩	10) Sand, fl to ml (177 to 350 ft) well sorted, dk gray org (10YR 6/6), subang mica: common to plentiful dk minerals: rare to common	
	3.7		⑪	11) clayey sand, ml to ml (250 to 500 ft) mod sorted, mod thick: dk gray org (10YR 6/6) to dk rd brown (10R 3/4) subang clay (25%)	
	3.8		37' 6"		
	3.9				
	4.0				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 3 OF
WELL NO. GLB-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY: "		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#7 40'-45'	40			1) Sand, fl to fl (125 to 250) well sorted, dk yw org (10YR 4/6), subang to subrand, dh minerals: common	
	41			numerous clay laminae: 2 to 10 mm thick, v	
	42			numerous clay laminae: 2 to 10 mm thick, v pale org (10YR 8/2) to pale yw brown (10YR 6/2)	
	43				
	44			2) clay: 80 mm thick, pale yw brown (10YR 6/6)	
#8 45-46'	45		100%	alternating clay laminae, pale yw brown (10YR 8/2) = 2 to 5 mm thick w sand laminae (as above) dk yw org (10YR 4/6)	
#9 46-47.3'	46			clay, pale yw brown (10YR 6/2) w numerous sand laminae (as above)	
#10 46.8-47.3'	47		46.9	(as above) * Measuring in 10 ft	
#11 47.3-49'	48		100%	clay w alternating sand (as described above) but well indurated, cemented, dense	
#12 49-49.3'	49			Same as above less indurated below some clay laminae, sand fl (125 to 177) well sorted	
#13 49.3-52'	50			subang to subrand, dh minerals: common, v pale org (10YR 8/6)	
	51			Same as above, pale yw brown (10YR 6/6)	
#14 52-53'	52		50.5	Same as above, pale yw brown (10YR 6/2) well indurated	
	53			Some as above, pale yw brown (10YR 6/2), dk yw org (10YR 4/6), much less indurated	
	54		53.7'	below some clay laminae, sand fl (125 to 177) as described above	
#15 55-59'	55			3) Sand, fl (177 to 250) well sorted, dk yw org (10YR 4/6), ang to subang, dh minerals: common	
	56			mica rare to common	
	57			numerous clay laminae but less than above 10% compared to 25% - 40%	
	58			4) clean sand, fl (125 to 177) well sorted, offwhite (10Y) to pale yw org (10YR 6/2), subang to subrand	
#16 59-65'	59		58.9'	dh minerals: common to plentiful	
	60			described on next sheet #14	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 4 OF
WELL NO. GC13-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
20-5 #17 65-72	60			same as above, but increase in alternating laminae	
	61			alternating laminae 2 to 10 mm thick of sand, clean sand, clay sand, FL (177 to 252) well sorted, dk grey (10YR 6/6), ang to subang, dh minerals; common clay (<1%)	
	62			clean sand, FL (125 to 177) well sorted, off white (10Y 8/2) to pale grey (10Y 8/2), subang to submed, dh minerals: common to plentiful	
	63				
	64		* 64.4'	clay, pale yellow brown (10YR 6/6) * iron oxide staining, med brown (5YR 3/4) grates into:	
20-6 #18 72-79	65			same as above: less laminae ↑ in size	
	66		1)	1) Sand, ml to c (250 to 500) well sorted, dk grey (10YR 6/6) subang to submed, dh minerals: common	
	67			numerous clay + clean sand laminae = 2 to 5 mm thick less than above ↳ pale yellow (10YR 6/6) w med rd brown (10R 4/6)	
	68		2)	2) Sand, cl to c (500 to 1000 or 1410) well sorted, dk grey (10YR 6/6), subang to submed	
	69			dh minerals: rare to common	
	70		1)		
	71		71.1'		
	72				
	73			Sand, ml to c (850 to 1000) med sorted, dk grey (10YR 6/6), med rd brown (10R 4/6), subang to submed, dh minerals: common, mica: common making	
	74			numerous clay + clean sand laminae = 2 to 5 mm thick	
20-7 #19 77-83	75			clay - off white (10Y 8/2), dk grey (10YR 6/6)	
	76		* 76.4'	* high concentration of dk heavy minerals laminae = 1 to 2 mm thick	
	77		* 77.4'	* iron oxide staining, v dusky rd purple (5R 3/2)	
	78				
	79		78.4'		
	80			description on sheet 5	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 5 OF
WELL NO. GCB-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#20 83-87	80		1)	1) Sand, ml to mlt (250 to 500 ϕ) med sorted, dk yw org (10YR 6/6), submed to med	
	81			dh minerals: common	
	82		2)	2) clay, pale yw org (10YR 8/6) iron oxide staining e base of clay, u dusky red purple (5RP 3/2)	
	83		3)	3) Sand mlt (350 to 500 ϕ) med to well sorted, dk rd brown (10R 3/4) w gry rd (10R 7/2)	
	84		4)	4) Sand cl to cll (500 to 1000 ϕ) med to well sorted, dk yw org (10YR 6/6) submed to med, dk h minerals: common, grades into:	
	85		5)	5) clay, pale yw org (10YR 8/6), iron oxide staining & cemented sand e base of clay, u dusky red purple (5RP 3/2)	
	86		6)	6) Sand cl to vcl (500 to 1410 ϕ , 2000 ϕ) med sorted, gry org (10YR 7/4), subang to submed	
	87			dh minerals: common	
	88		7)	7) clay, pale yw org (10YR 8/6), iron oxide staining e base of 1" clay laminae	
	89		8)	8) Sand cl to vcl (500 to 1410 ϕ) poorly to med sorted, dk yw org (10YR 6/6), subang to submed	
	90			dh minerals: common, numerous thin clay laminae within clay	
	91			Sand, clayey, ml to cl (350 to 710 ϕ) poorly to med sorted, dk yw org (10YR 6/6), subang to submed	
	92			sharp contact w clay, dk yw org, iron oxide staining e base of clay, u dusky red purple (5RP 3/2)	
	93				
	94			Sand, fl to mlt (175 to 500 ϕ) med sorted, gry org (10YR 7/4), ang to subang,	
	95			dh minerals: common	
	96			thin clay laminae $\approx$ 2 mm thick	
	97				
	98			9) Sand, fl to mlt (125 to 350 ϕ) well sorted gry org (10YR 7/4), well med, mica: common	
	99			dh minerals: common grades into:	
	100			color change: $\approx$ 95 pale yw org (10YR 8/6)	
				back into: gry org 10YR 8/4 $\approx$ 97'	
				numerous thin clay laminae $\approx$ 2 to 4 mm thick, pale yw org (10YR 8/6)	
				sand grades into: pebbles, (< 5% $\approx$ 3 mm thick)	
				10) Sand, mlt to vcl (350 to 1410 ϕ) poorly to med sorted, gry org (10YR 7/4), subang to submed	
				mica: common dh minerals: common	
				top 4mm Sand, mlt to cl (350 to 1000 ϕ) med sort, subang to submed	
				clay, pale yw org (10YR 8/6)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 6 of
WELL NO. GC13-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#26 102'-105'	100		100.2		
	101				
	102		100%		
	103			Sand ml to vcl (350 to 2000 ϕ) pebbles (45% top 1st increase to $\approx$ 10% bottom 1st of run, 3 to 6 mm (ch)) poorly sorted, med gas brown (10YR 5/4), submed, dh minerals: rare to common grades into:	
#27 105'-108'	104			three clay laminae 10 to 30 mm thick, iron oxide staining at the top & base of 2nd clay & heavily stained $\approx$ 5 mm thick below the 3rd clay laminae	
	105				
	106			Sand, ml to ch (350 to 710 ϕ) well sorted, med gas brown (10YR 5/4), med dh minerals: common	
#28 108'-112'	107				
	108				
	109		108.7	Sand, same as above, loose, pore, siliceous, running sand	
	110				
	111				
#29 112'-115'	112			Sand, cl to vcl (500 to 2000 ϕ) pebbles, (15 to 20% 2 to 5 mm (ch)) poorly sorted, submed med gas brown (10YR 5/2), dh minerals: rare to common grades into:	
	113			Sand ml to cl (250 to 1000 ϕ , 2000 ϕ) med sorted, med to subang	
	114				
#30 115'-116'	115		0%		
#31 116'-118'	116				
	117			Sand, ml to ml (250 to 500 ϕ) well sorted, med gas brown (10YR 6/2) submed to med, mica: common, dh minerals: common	
#32 118'-120'	118		117.7		
	119		118.5	Sand, ml to cl (250 to 1000 ϕ) poorly sorted, well med, dh minerals: common	
	120				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 7 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#33 120-123	12.0			Sand, vcl to vcl (1000 to 2000+) pebbles (25% 5 to 7 mm thick), pale yw brown (10YR 4/2), subnd (lay depositor)	
	12.1			* $\approx$ 30 mm thick iron oxide cemented ss ^{porritic} * CONTACT *	
	12.2				
#34 123-124	12.3			no recovery	
#35 124-126	12.4			pebbles: (10%, 3 to 7 mm thick)	
	12.5			Sand, ml to vcl (350 to 1410 or 2000+) poorly sorted, med yw brown (10YR 5/4), subnd, dh minerals: rare to common	
#36 126-126.5	12.6		125.4		
#37 126.5-128	12.7		126.3	Sand, cl to vcl (500 to 2000+) pebbles (5%, 3 mm thick) poorly to mod sorted, subnd grades into:	
#38 128-131	12.8		127.4	Sand, coarser than above, granitic (25%) grades into:	
	12.9			Sand, cl to vcl (500 to 2000+) pebbles (22.5%, 3 to 6 mm thick) poorly to mod sorted, subnd, drk yw org (10YR 6/6), dh minerals: common grades into:	
	13.0			$\approx$ 129.3 numerous thin clay laminae $\approx$ 2 to 3 mm thick, pale yw org (10YR 8/6), gray org (10YR 7/4)	
#39 131-134	13.1			$\approx$ 129.5 clay, pale yw org (10YR 8/6) to drk yw org (10YR 4/6) w thin sand laminae $\approx$ 2 mm thick	
	13.2			Clayey Sand, fl to fl (125 to 250+) mod to well sorted, drk yw org (10YR 4/6), light brown (5YR 5/6) mica: abundant clay (30%) talcy texture	
	13.3			numerous thin clay laminae $\approx$ 2 to 5 mm thick, pale yw brown (10YR 4/2)	
#40 134-138	13.4				
	13.5			Sand, fl to ml (177 to 350+) mod to well sorted, off white (10YR 8/1) w drk yw org (10YR 6/6) ang, mica: abundant, dh minerals: common, clay (5%) talcy texture	
	13.6			numerous thin clay & clean sand laminae $\approx$ 3 to 7 mm thick	clay: pale yw brown (10YR 4/2)
	13.7			* iron oxide staining $\approx$ 1/5 mm thick gray brown (5YR 3/2)	
#41 138-143	13.8			$\approx$ 137.5 bedding of laminae is $\approx$ 35° off horizontal	
	13.9			as above, increase in iron oxide laminae	
	14.0			grades into:	
				Sand, ml to vcl (350 to 1410 or 2000+) poorly to mod sorted, drk yw org (10YR 6/6)	
				ang, mica: common to plentiful, dh minerals: rare to common	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 8 OF
WELL NO. GC13-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	140			Sand as described above: increase in iron oxide staining lamine	
	141			grades into:	
	142		142.6	≈ 142' Sand, ml to ch (350 to 710 v) mod sorted, drk gray (10YR 4/6) mica: abundant flake ≈ 3m. dh minerals: common grades into:	
	143			Sand, ml to vch (250 to 2000 v) pebbles (40% highly concentrated ≈ 144' 3 to 20 mm thick) subang to submed, drk gray (10YR 4/6), mica: common dh minerals: common iron oxide staining of sand ≈ 10cm above 144', mod brown (5YR 3/4)	
	144				
	145			Sand, ml to ch (350 to 1000 v) poorly sorted, off white (10Y 5/6) light brown (5YR 5/6) submed, mica: abundant, clay (5%) tabular texture grades down into:	
	146			Sand, ch to vch (710 to 2000 v) pebbles (18%, 5 mm thick) subang to submed grades into:	
	147		147.8	Sand, as above, pebbles (40%, 5 to 20 mm thick)	
	148		100%	Sand as above, grade into:	
	149			≈ 148.5' Sand, ml to ml (250 to 500 v) mod sorted, off white (10Y 5/6), ang to subang mica: abundant dh minerals: common clay (5%) tabular texture	
	150			numerous thin clay + clean sand lamine, some iron oxide staining of sand	
	151				
	152				
	153				
	154			1) Sand ch to vch (500 to 1410 v) mod sorted, gray (10YR 7/4), ang, mica: rare common, dh minerals: common grades into: sand size increase, pebbles (5 to 10% 5 to 10 mm thick) clay ball 5 mm thick	
	155		100%	2) numerous thin alternating lamine ≈ 3 to 5 mm thick of clean sand, clayey sand, iron oxide staining, v drk rd (5R 7/6) micaceous sand fl to FU (125 to 250 v) vll sorted, v pale (10YR 8/6) to pale gray (10YR 8/6) clay (10%) numerous thin lamine of iron oxide staining ≈ 1 to 2 mm thick mod drk 5YR 3/6 to v drk rd (5R 7/6)	
	156			clay, mottled, yw gray (5Y 8/1) to gray pink (5YR 7/2), mod rd (5R 3/4), v drk rd (5R 3/6)	
	157				
	158		100%	clay mottled, as described above, change contrast in lts below:	
	159			1) Sandy clay, sand, fl to ml (177 to 350 v) mod to well sorted, ang to subang, mottled, gray pink (5YR 7/2) to gray rd purple (5RP 7/3), v drk gray rd purple (5R 7/2)	
	160				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 9 OF
WELL NO. GC13-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
160	160		100%	1) silty sand/sandy clay, sand, m.f. to c.f. (350 to 1000 or 2000 or), poorly to mod sorted, y. pale org (10YR 7/2), arg to subarg, dh minerals: common, clay (10 to 15%)	
161	161		1)		
162	162		2)	2) silty, silty clay, mottled, y. g. (5Y 7/1) to mod. pink (5R 7/4)	
163	163		3)	3) iron oxide staining of sand laminae = 2 mm thick, sand, v. to w. (1000 to 2000 or) pebbles (15% 3 to 5 mm thick)	
164	164		3)	3) iron oxide cemented laminae = 5 mm thick, v. to w. (1000 to 2000 or) pebbles (15% 3 to 5 mm thick)	
165	165		4)	4) micaceous sand, f. to m. (175 to 350 or) well sorted, off white (N9) to pale gray (10YR 7/2) arg, mica abundant, clay (< 5%)	
166	166		5)	5) Sand to clay, sand, c.f. to v. c.f. (500 to 2000 or) poorly to mod sorted, off white (N9) to pale org (10YR 7/2) arg to subarg, mica: common, dh minerals: common to abundant, clay (15%)	
167	167		5)	5) alternating laminae = 2 to 10 mm thick of clean sand, clayey sand, iron oxide staining mod. red (5R 4/6)	
168	168		5)	5) grades into: = 165' pebble sand, pebble (35 to 30%, 3 to 10 mm thick) mod. to well sorted, clay (15%)	
169	169		5)	5) micaceous sand = 3 mm thick, sand, f. to m. (175 to 350 or) well sorted, arg, clay (10%), iron oxide staining, c.f. to w. c.f.	
170	170		5)	6) Sand, c.f. to m. (500 to 1000 or, 140 or) well sorted, off white (N9), arg to subarg, mica: common to abundant, dh minerals: common, clay (10 to 15%) clay texture	
171	171		100%	6) alternating laminae = 2 to 10 mm thick of clay sand, mod. y. (5Y 7/6), clean sand, + iron oxide staining, v. to w. c.f. to w. c.f. (5R 4/6)	
172	172		0%	100% Recovery	
173	173		100%	7) Sand, c.f. to v. c.f. (100 to 2000 or) pebbles (5 to 10%, 3 to 5 mm thick), y. to w. (5Y 7/2), off white (N9), subarg to submod. mica: common, dh minerals: rare, clay (5%)	
174	174		7)	7) iron oxide staining = 10 mm thick, d. to w. (10R 7/4)	
175	175		8)	8) micaceous sand, c.f. to v. c.f. (500 to 1410 or) mod sorted, off white (N9), arg, mica: abundant, clay (20%) clay texture	
176	176		9)	9) grades into: sand, v. to w. (1000 to 2000 or) pebbles (30% 3 to 10 mm thick) mod. to well sorted, clay (30 to 30%)	
177	177		10)	9) Sand, c.f. to v. c.f. (100 to 2000 or) poorly to mod sorted, arg, dh minerals: common, clay (2 to 5%)	
178	178		10)	10) Sand, v. c.f. (1410 to 2000 or) pebbles (60%, 3 to 10 mm thick) poorly sorted, arg to subarg grades into:	
179	179		11)	11) Sand, c.f. to v. c.f. (500 to 1410 or) pebbles (5% 3 to 5 mm thick) mod sorted, off white (N9) to pale org (10YR 7/2), arg to subarg, mica: abundant, dh minerals: common, clay (12%)	
180	180		11)	11) alternating laminae = 2 to 10 mm thick of clay off white (N9), clean sand, clayey sand	
			11)	some thin beds of pebbles (3 to 5 mm thick)	
			179.8		

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET
			10 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO.	SRP COORDINATES	DRILLER	
GC13-3			
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#51 181-185	180		100%	1) micaceous sand, ml to cl (350 to 1000 ϕ , 1410 ϕ) well sorted, off white (U9) to gray (5Y 7/4), ang mica: abundant, dh minerals: rare, clay (10%), clay balls $\approx$ 10 mm in diameter	
	181			2) iron oxide staining $\approx$ 10 mm thick, mod brown (5YR 3/4)	
	182			3) Sand, ch to vch (500 to 1410 ϕ) pebbles (15% 3 to 7 mm thick mod) mod sorted, off white (U9), ang, dh minerals: common, mica: common	
	183			alternating 10% laminae of clean sand, clayey sand: pale yellow (10YR 8/6), iron oxide staining	
	184			4) Sand, fl to rh (171 to 350 ϕ) well sorted, off white (U9) to pale gray (10Y 7/2), ang to subang, mica: abundant, dh minerals: rare, clay (10 to 15%) clayey sand grades into:	
	185			5) Sand, ch to vch (710 to 2000 ϕ) pebbles (15%, 3 to 5 mm thick) poorly sorted, off white (U9) to pale yellow (10YR 8/6), ang to subang, dh minerals: plentiful, mica: common, clay (25%)	
	186			6) clay interbedded to sand laminae, clay $\approx$ 3.5 to 8 mm thick, yellow (5Y 7/2)	
	187			micaceous sand, fl to rh (171 to 350 ϕ) mod to well sorted, pale gray (10Y 7/2), ang mica: abundant, clay (10%)	
	188			alternating clean sand, clay sand & iron oxide staining dk yellow (10YR 6/6)	
	189			7) micaceous sand, ml to cl (350 to 1000 ϕ , 1410 ϕ) mod to well sorted, off white (U9) to pale gray (10Y 7/2), ang mica: abundant, dh minerals: rare, clay (10%)	
	190			alternating laminae $\approx$ 2 to 7 mm thick, of clean sand, clayey sand, iron oxide staining, dk yellow (10YR 6/6) grades into:	
	191			micaceous sand, ch to vch (500 to 2000 ϕ) mod sorted, ang to subang	
	192				
#53 192-197	192				
	193			8) Sand, ch to vch (710 to 2000 ϕ) pebbles (40%, 3 to 12 mm thick) poorly to mod sorted, subang to subvch mica: common to plentiful, off white (U9), clay (10%)	
	194			9) Sand, ml to rh (350 to 1410 ϕ) mod sorted, off white (U9), ang to subang, mica: plentiful, grades into: c $\approx$ 19.5 sand ch to vch (710 to 2000 ϕ) pebbles (25%, 3 to 7 mm thick) poorly to mod sorted, off white (U9), subang to submod, mica: common, clay (2%), some thin laminae $\approx$ 2 to 5 mm thick of clayey sand, dh minerals, clean sand	
	195			10) iron oxide staining $\approx$ 10 mm thick, light brown (5YR 5/6)	
	196			11) Sand, ml to vch (350 to 1410 ϕ , 2000 ϕ) poorly to mod sorted, off white (U9), ang to subang, mica: common, clay (2%), dh minerals: common	
	197			alternating laminae (20%) $\approx$ 2 to 5 mm thick, of clayey sand, clean sand	
#54 197-202	198			12) Sand, ml to vch (350 to 1410 ϕ , 1410 ϕ) poorly sorted, off white (U9) to pale gray (10Y 7/2) subang, clay (5%), some thin laminae $\approx$ 5 to 10 mm thick of clay, clayey sand, pale yellow (10YR 8/6)	
	199			13) iron oxide staining $\approx$ 15 mm thick, mod brown (5YR 3/4)	
	200			14) Sand, ch to vch (500 to 1410 ϕ , 2000 ϕ) poorly to mod sorted,	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET // OF
WELL NO. GC3-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#55 202- 206	20.0		1)	1) Sand ml to vch (350 to 1410 or 2000+) poorly to med sorted, off white (W), ang. to subang, mica: common, iron oxide staining thru lower laminae ~ 5 to 10mm thick, gray purple (SRP 1/2) to v dusky rd purple (SRP 3/2)	
	20.1		2)	* iron oxide staining on top of clay layer below ~ 5mm thick, v dusky rd purple (SRP 3/2)	
	20.2		100%	2) clay, med indurated, yw gry (5Y 3/1)	
	20.3		3)	3) clay, mottled, yw gry (5Y 3/1) to gry rd purple (SRP 1/2), v dusky rd purple (SRP 3/2) mottled might be due to iron oxide staining	
#56 206- 213	20.4			in sharp contrast w:	
	20.5		4)	4) sand, fl to mch (177 to 357) well sorted, off white (W), ang, mica: abundant, clay (5%) iron oxide staining ~ 5mm thick, v dusky rd purple 3/2	
	20.6		100%		
	20.7			micaceous sandy, mch to ch (850 to 710+) well sorted, off white (W) to pale gray (10Y 8/2), ang, mica: abundant, dh minerals: common, clay (5 to 10%)	
#57 213- 217	20.8			* iron oxide staining ~ 5mm thick, some cementation, v dusky rd purple (SRP 3/2) grades into:	
	20.9				
	21.0			~ 210' micaceous sand, fl to mch (177 to 500+) well sorted, off white (W) to pale gray (10Y 8/2), ang, mica: abundant, dh minerals: common, clay (5%)	
	21.1				
#58 217- 220	21.2			sand, fl to fl (125 to 250+) med to well sorted, off white (W) to pale gray (10Y 8/2) ang to subang, v micaceous: abundant, clay (20%) clay texture (silty)	
	21.3		1)	some iron oxide stained laminae	
	21.4		2)	1) micaceous sand, fl to fl (125 to 250+) med to well sorted, off white (W) to light gray (5Y 6/6) ang to subang, mica: abundant to plentiful, dh minerals: rare to common, clay (10-20%) clay texture	
	21.5		2)	* iron oxide staining of sand, light brown (5Y 5/6)	
#58 217- 220	21.6		216.3	2) Sand ml to ch (350 to 1000 or 2000+) med sorted, fl white (W) to pale gray (10Y 8/2) ang to subang, mica: abundant, dh minerals: rare to common, some streaks of dh minerals ~ 2mm thick, clay (5%), some clean sand laminae throughout section	
	21.7			** clay lens ~ 10mm thick, v light gray (W)	
	21.8		3)	3) micaceous sand, ml to ch (350 to 710+) med to well sorted, off white (W) to yw gry (5Y 8/1), subang to submed, mica: common to abundant, dh minerals: common, grades down into after iron oxide staining	
	21.9		1)	* iron oxide staining ~ gradual change in gr size, ~ 30mm thick, high concn of dh minerals	
#58 217- 220	22.0		5)	4) Sand, vch to vch (1000 to 2000+) pebbles (25%, 3 to 5mm thick) poorly to med sorted, off white (W) to yw gry (5Y 8/1) subang to submed, mica: rare to common, dh minerals: common, clay (5%) alternating laminae of clean sand to clay sand	
				5) Sand ml to ch (350 to 710+) med sorted, subang to submed, alternating clean sand, clay sand, dh mineral streaks, iron oxide staining, laminae, all ~ 2mm thick, clay (25-30%) clay texture	

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WELL NO. GA3-3	REFERENCE DATUM	DRILLING CONTRACTOR
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	COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#57 220- 225	22.0		1)	1) Sand, all to ucl (710 to 2000 v) pebbles (30 to 40% 5 to 15 mm thick) poorly sorted, off white (U9)	
	22.1			dh minerals abundant, some streaks grades down into:	
	22.2		2)	2) Sand, cl to ucl (500 to 1410 v) med sorted, off white (U9) to pale org (10YR 8/2), subang, dh minerals abundant to plentiful high concentration from 221' to 221.8' alternating laminae of clayey sand & clayey silt	
	22.3		3)	3) Sand, ml to ucl (250 to 2000 v) pebbles (30 to 40% 5 to 8 mm thick) poorly sorted, off white (U9), subang, dh minerals common clay (5%) grades down into:	
	22.4		4)	4) Silty sand, cl to ucl (710 to 2000 v) med to well sorted, off white (U9), silty to subang, dh minerals common, clay (5%)	
	22.5		5)	5) Sand, ml to cl (250 to 1000 v) med sorted off white (U9) to light org (10YR 8/6), ang mica abundant, dh minerals rare to common clay (10%) talcy texture	
#60 225- 232	22.6		6)	6) Same as above	
	22.7		7)	7) iron oxide staining, some cemented 2-20 mm thick dusky brown (5YR 3/2)	
	22.8		8)	8) micaceous sand, ml to ucl (350 to 1410 v 2000 v) med sorted, off white (U9), subang, mica abundant, dh minerals rare to common clay (10%) talcy texture, grades down into fine sand	
	22.9		9)	9) clayey sand, fl to ml (17 to 350 v) clay (30 to 40%) v talcy texture	
	23.0		10)	10) contact w iron oxide zone silty clay 20 mm thick, g/y (5Y 8/1)	
	23.1		11)	11) iron oxide staining of sand 20 mm thick, iron oxide cement laminae (zone) 20 mm thick c 20 mm off base of staining	
	23.2		12)	12) Sand, ml to ucl (350 to 2000 v), pebbles (10%, 3 to 5 mm thick) med sorted, off white (U9), subang to subang	
	23.3		13)	13) dh minerals common, mica common, clay (15%)	
	23.4		14)	14) alternating clayey sand & clean sand laminae	
#61 232- 237	23.5		15)	15) Sand, all to ucl (350 to 1410 v) med sorted, off white (U9), subang, dh minerals common, mica common, clay (15%) ang	
	23.6		16)	16) 3 clay laminae 15 to 20 mm thick separated by sand 5 mm thick, pale gray (10Y 8/2)	
	23.7		17)	17) grades into:	
	23.8		18)	18) Sand, ml to ucl (350 to 2000 v) pebbles (10%, 4 to 6 mm thick), poorly sorted, off white (U9) to pale gray (10Y 8/2), subang to subang, dh minerals common	
	23.9		19)	19) alternating laminae of clean sand, clayey sand, iron oxide staining, dh minerals grades into:	
#62 237- 245	24.0		20)	20) clayey micaceous sand, fl to ucl (250 to 250 v) med to well sorted, off white (U9), ang to subang, mica abundant to plentiful, dh minerals rare, clay (20%) talcy texture	
			21)	21) iron oxide staining 15 mm thick dusky brown (5YR 3/2)	
			22)	22) micaceous sand, cl to ucl (500 to 2000 v) pebbles (5% 3 to 5 mm thick) poorly to med sorted, off white (U9), subang to subang, mica plentiful, dh minerals common, clay (10%) talcy texture grades into:	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 13 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#63 245-253	240		1)	1) as described above	
	241		2)	2) clayey, micaceous sand, fl to fll (125 to 250) med well sorted, gray (5YR 4/4), mica abundant, illminerals: rare, clay (25%) sandy texture, grades into:	
	242				
	243		3)	3) micaceous sand, ml to vch (350 to 1410 or 2000) med sorted, off white (10Y 8/4) to gray (5YR 4/4), subang to subind, mica: plentiful, illminerals: rare, clay (10%) sandy texture	
	244			numerous thin laminae = 2 to 5 mm thick of clayey sand, clean sand & gravel 3 to 6 mm thick	
	245		100%		
	246			* iron oxide staining = 5 mm thick, redish brown (5YR 3/2)	
	247				
	248			micaceous sand, fl to ml (175 to 350) med well sorted, off white (10Y 8/4) to pale gray (10Y 8/2), mica: plentiful, illminerals: rare, clay (10%) sandy texture	
	249			numerous thin laminae of iron oxide staining 2 mm thick, pale gray (10Y 8/6)	
#64 253-258	250			grades down into:	
	251			micaceous sand, ml to vch (350 to 1410 or 2000)	
	252				
	253				
	254			micaceous sand, ml to vch (250 to 1410 or 2000) med sorted, off white to pale gray (10Y 8/2), mica: plentiful, illminerals: common, clay (15%) sandy texture	
	255				
	256			numerous thin laminae of iron oxide staining = 2 mm thick, pale gray (10Y 8/6)	
	257			bedding = 30 to 45% at horizontal	
	258				
	259			micaceous sand, ml to cl (250 to 1000 or 1410) med well sorted, off white to pale gray (10Y 8/2), mica: plentiful, illminerals: rare, clay (15%) sandy texture	
#65 258-265	260			grades into:	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 14 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
260				micaceous sand, mlt to vch (350 to 1410 + 2000+) mod sorted, off white (10%) to pale gray (10 1/2%) any to subang, mica: plentiful, dh minerals: common, clay (5%) clay texture	
261				grades down into	
262				1) micaceous sand, mlt to vch (350 to 2000+) pebbles (5% from 262.5 to 263 then 15% from 263 to 264' 3 to 6 mm thick) subang to subbed, poorly to mod sorted, clay (5%) clay	
263				clay content increase towards 264' mod iron oxide staining (10 to 15%) clay texture	
264				* iron oxide staining = 1 mm thick velvety brown (SR 3/4) numerous thin laminated iron oxide staining = 2 mm thick bedding = 45° off horizontal	
265				2) micaceous sand, fl to mlt (177 to 350+) well sorted, any to subang, clay (10-15%) clay texture	
266					
267				micaceous sand (fl to mlt) (177 to 500+) well sorted, off white (10%) to pale gray (10 1/2%) any, subang, mica: plentiful, dh minerals: rare, clay (5%) clay texture	
268				numerous thin laminae of iron oxide staining = 1 to 2 mm thick, mod rd (SR 1/6)	
269				* iron oxide staining = 10 mm thick mod gray (SR 1/6)	
270				grades into	
271				micaceous sand, mlt to vch (350 to 1410 + 2000+) mod sorted, any to subang	
272					
273				272.8	
274			0%	No Recovery	
275			0%	No Recovery	
276				* iron oxide staining = 32 mm thick, mod rd (SR 1/6)	
277				micaceous sand, vch to ch (250 to 710+) well sorted, off white (10%) to pale gray (10 1/2%) any to subang, mica: abundant, dh minerals: common	
278					
279				grades into	
280				279.8	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 15 OF
WELL NO. GC13-3		REFERENCE DATUM	DILLING CONTRACTOR
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		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#70 280- 285	280				
	281			Sand, cl to ucll (500 to 2000+) pebbles (5% 5mm thick) poorly sorted, off white (W) to pale gray (10Y 7/2)	
	282			subang, to subang, mica: common - plentiful, dhminerals: common, clay (2%)	
	283			numerous thin laminae of iron oxide stained sand, med gray (5Y 7/2) = 2mm thick	
	284			clay lenses c 283, off white (W), = 3mm thick	
#71 285- 287	285		284.9		
	286			* iron oxide staining = 8mm thick alternating from dk gray to 10YR 4/6 (limb) to dusky rd (10R 3/2)	
	287			Sand, as above	
				large pebbles c top of iron oxide staining = 5 to 10mm thick	
#72 287- 292	287		286.7	* iron oxide staining = 10mm thick	
	288			* iron oxide staining = 50mm thick, med brown (5YR 3/4)	
	289			1) Sand, cl to ucll (710 to 2000+) pebbles (10% 3 to 5mm thick) off white (W) to pale gray (10Y 7/2)	
				subang to subang, mica: common, dhminerals: common to plentiful	
	290			2) Clay laminae = 1mm thick interbedded w pebbles 10 to 15mm thick iron oxide staining of the sand	
				clay - off white (W) sand - dusky rd (5R 3/4)	
	291			3) Sand, cl to ucll (710 to 2000+) pebbles (25% 5 to 15mm thick)	
#73 292- 295	292		291.5		
				large gr pebble, ang (gizire) = 30mm thick located c 292'	
	293			* iron oxide staining = sand, 20mm thick dk gray (10YR 4/6) ** = 5mm thick, v dusky rd purple (5R 3/2)	
	294			4) Sand, cl to ucll (500 to 2000+) pebbles (25% 3 to 5mm thick) poorly sorted, off white (W) to pale gray (10Y 7/2) ang to subang, mica: common, dhminerals: common, clay (10%)	
	295			* iron oxide staining = 30mm thick, v dusky rd (10R 3/2), med ball above lamina	
#74 295- 300	295			5) Sand, cl to ucll (710 to 2000+) poorly sorted, ang to subang	
	296			6) Sand interbedded w clay laminae, sand, cl to ucll (710 to 2000+) pebbles (25% 5 to 10mm thick) subang, poorly sorted	
	297			clay - off white (W)	
	298			7) Sand, silty, med to ucll (350 to 2000+) pebbles (25% 5 to 10mm thick) poorly sorted, off white (W) to pale gray (10Y 7/2), subang, dhminerals: common, clay (10%)	
	299			laminar & clean sand & clayey sand = 5 to 10mm thick	
	300			grades into:	
				8) sand, vlt to ch (350 to 710+) med sorted, ang, mica: rare, dhminerals: common, clay (5 to 10%)	

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REFERENCE DATUM		DILLING CONTRACTOR	16 OF
WELL NO.	SRP COORDINATES	DRIER	
LOGGED BY	COMPANY	DILLING METHOD	
RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY
300	300		
301	301		
302	302		
303	303		
304	304		
305	305		
306	306		
307	307		
308	308		
309	309		
310	310		
311	311		
312	312		
313	313		
314	314		
315	315		
316	316		
317	317		
318	318		
319	319		
320	320		

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 17 OF
WELL NO. GLB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#83 320-324	320		100%	1) Sand, mltro vcl (350 to 2000+) pebbles (30% rap ban, 3 to 12 mm thick, red), poorly sorted, off white (W) to pale grn yw (10Y 8/3), subang to subrnd, dhminerals: common to plentiful, mica: rare to common, some thin laminae of clayey sand dhminerals, grades into:	
	321			2) Sand, mltro vcl (350 to 1000 to 1410+) mod sorted, off white (W) to pale grn yw (10Y 8/3), ang to subang, mica: common, dhminerals: rare to common, sharp contact w:	
	322			* iron oxide staining = 2 mm thick	
	323			3) Sand, chro vcl (500 to 2000+) pebbles (50% rap 4 cm + horizon 3 cm, 30% in lower, 3 to 10 mm thick, red), subang to subrnd, mica: common, dhminerals: common, sharp contact w:	
#84 324-331	324			4) clay, mottled, yg gr (5Y 8/1), gr yw (5Y 8/4), mod rd (5R 4/6), v. dk rd (5R 3/6)	
	325				
	326				
	327			clay, semi mottled, yg gr (5Y 8/1) w gr yw (5Y 8/4)	
	328			staining laminae, streaks/bands of pinkish purple (5R 4/2) to mod rd (5R 4/6), (= 2 to 5 mm thick) from 324'-325'	
	329				
	330		330.2		
#85 331-334	331			5) silty clay, v pale org (10YR 8/2), mica: abundant	
	332			* iron oxide staining = 7 mm thick, some cementation, org rd purple (5R 4/2), v. dk rd purple (5R 2/2)	
	333			6) micaceous sand, fl. (175 to 500+) well sorted, off white (W) to v pale org (10YR 8/2), ang, mica: abundant, clay (2%) clay texture	
	334		333.8	* iron oxide staining = 5 mm thick, v. dk rd purple (5R 2/2)	
#86 334-337	334			7) silty clay, poorly indurated, v pale org (10YR 8/2), mica: abundant	
	335			silty clay, poorly indurated, v pale org (10YR 8/2), mica: abundant grades into:	
	336			Sand, fl. (125 to 350+) well sorted, off white (W) to v pale org (10YR 8/2), pale yw org (10YR 8/6), ang to subang, mica: abundant, dhminerals: rare to common, clay (2%) clay texture	
#87 337-341	337		336.9		
	338			micaceous sand to silty clay, sand fl. (125 to 175 to 250+) well sorted, off white (W) to v pale org (10YR 8/2), pale yw org (10YR 8/6), ang, mica: abundant, clay (2.5%)	
	339			* Some iron oxide laminae = 2 to 10 mm thick, light rd (5R 6/6) to mod rd (5R 5/4)	
	340			some coarse grain sand that makes up the iron oxide laminae, sand fl. (175 to 350+)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 18 OF
WELL NO. 6013-3		REFERENCE DATUM	DILLING CONTRACTOR
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		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
307 33 341- 346	340			as described above on sheet 17	
	341		340.6		
	342			micaceous sand, fl to fl (125 to 250+) well sorted, gray w (5Y 8/4), mica: abundant, clay minerals: rare, clay (2%) silty texture grades into:	
	343				
	344			~343' micaceous sand, fl to ml (125 to 350+) well sorted, gray w (5Y 8/4), mica: abundant, clay minerals: rare, clay (2%) silty texture grades into:	
345 346 353	345			~345' micaceous sand, fl to ml (125 to 350+) well sorted, gray w (5Y 8/4), mica: abundant, clay minerals: rare, clay (2%) silty texture grades into:	
	346		345.9		
	347				
	348			micaceous sand, fl to ml (125 to 500+) well sorted, off white (10Y 8/1) to gray w (5Y 8/4), mica: abundant, clay minerals: rare, clay (2%) silty texture grades into:	
	349			* some iron oxide staining = 1 to 4 mm thick, mod red (5R 4/6) to dark red (5R 3/6), velvety red purple (5RP 3/2)	
350 351 352 353	350				
	351				
	352				
	353		352.8		
	354			micaceous sand, fl to ml (125 to 500+) well sorted, off white (10Y 8/1) to gray w (5Y 8/4), mica: abundant, clay minerals: rare, clay (2%) silty texture grades into:	
355 356 357 358	355			~354' sand, fl to well (710 to 2000+) granules (10 to 15%, 3 to 7 mm thick) mod sorted, pale gray (10Y 7/2), silty to subbrn	
	356			some thin laminae of clay, clayey sand ~ 3 to 7 mm thick, from 356 to 356.5, gray (5Y 8/1)	
	357		357	a) silty clay, gray (5Y 8/1) to pale gray (10Y 7/2), mica: abundant	
	358				
	359			silty clay, gray (5Y 8/1) grades into:	
360 361	360			~360' sandy clay, gray (5Y 8/1) sand, fl to fl (125 to 177+) well sorted, gray to subgray, mica: plentiful to abundant	
	361				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 19 OF
WELL NO. GC13-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#92 361- 363	360		360.2		
#93 363- 365	361			Sand, flint (125 to 250 μ) well sorted, off white (U) to gray (5Y 7/4) to gray (5Y 8/4) any mica: plentiful, dhminerals: common grades into:	
	362			alternating thin laminae $\approx$ 5 to 10 mm thick of clay, clayey sand, iron oxide staining, pale gray (10YR 8/6)	
#94 365- 372	363		362.7 100%	362.5 micaceous sand, flint (125 to 250 μ) well sorted, off white (U), subang	
	364			Sand, mlt to cl (350 to 1000 μ) mod sorted, off white (U) to ? run, any to subang. mica: plentiful, dhminerals: common	
	365			1) Sand, mlt to cl (250 to 1000 μ) mod to well sorted, off white (U) to gray (5Y 7/4), subang to subang mica: common to plentiful, dhminerals: rare to common.	
	366			some thin laminae $\approx$ 2 to 5 mm thick of clayey sand, gray (5Y 8/4) to pale yellow (10YR 8/6) grades into:	
	367			* iron oxide staining $\approx$ 2 mm thick, dk brown (10YR 4/6)	
	368			2) Sand, flint (170 to 410 μ) poorly sorted, off white (U) to gray (5Y 7/4), subang mica: plentiful, dhminerals: rare to common, grades into:	
	369				
	370			* iron oxide staining $\approx$ 7 mm thick, light brown (5YR 5/6) to mod brown (5YR 4/4)	
	371			3) Sand, mlt to cl (340 to 1000 μ , 410 μ) mod to well sorted, off white (U) to gray (5Y 7/4), subang subang to subang, mica: common, dhminerals: rare	
#95 372- 376	372		371.4		
	373			4) Sand, mlt to cl (350 to 410 μ , 2000 μ) mod sorted, off white (U) to gray (5Y 7/4), any to subang, mica: common, grades into:	
	374			373.5 sand, mlt to cl (500 to 2000 μ) pebbles (10%, 3 to 4 mm thick) mod sorted, gray (5Y 7/4), any to subang, grades into:	
	375			alternating thin laminae $\approx$ 3 to 10 mm thick, from 374 to 374.3, of clayey sand & clean sand	
	376			5) Sand, flint (125 to 250 μ) poorly mod sorted, gray (5Y 8/4) any to subang, mica: common to plentiful, dhminerals: common, clay (2%)	
#96 376- 380	377			6) Sand, mlt to cl (250 to 2000 μ) pebbles (5 to 10%, 3 to 5 mm thick) poorly sorted, off white (U) to gray (5Y 7/4), subang, mica: plentiful, dhminerals: rare to common, grades into:	
	378			some thin laminae $\approx$ 2 to 5 mm thick, of clay, clayey sand, off white (U)	
	379			7) Sand, flint (125 to 250 μ) well sorted, gray (5Y 8/4) to pale yellow (10YR 8/6), subang to subang, mica: common to plentiful, dhminerals: common	
	380		379.3		

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 20 OF
REFERENCE DATUM		DRILLING CONTRACTOR	
WELL NO. 6613-3	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#77 380- 383	380		1)	1) Sand, flint rock (125 to 350+) med sorted, off white (L4), ang ro subang, mica: common to plentiful, d/minerals: common grades into: sand, mlt rock (250 to 2000+) above immediate	
	381		2)	2) iron oxide staining = hematite cementation ± 2mm thick, velvety rd purple (SRP 3/2)	
	382		3)	3) Sand, clt to vel (710 to 8000+) pebbles (10% 2 to 5mm thick) med sorted, off white (L4), subang to submed clay (3%) mica: common	
#78 383- 387	383		4)	4) clay, gray gr (5YR 1/1)	
	384		5)	5) Sand, mlt rock (250 to 2000+) poorly sorted, off white (L4) to pale gray (10Y 8/2), ang ro subang, mica: common d/minerals: common clay (2%)	
	385		6)	6) clay, gray gr (5YR 1/1), grades into: silty/sandy, clay, sand, off white (L4) to off white (80 to 250+)	
	386		7)	7) iron oxide staining = 10mm thick, velvety rd purple (SRP 3/2)	
	387		8)	8) Sand, flt to flt (125 to 250+ 350+) well sorted, off white (L4), ang ro subang, d/minerals: common mica: common	
#99 387- 388	387		9)	9) iron oxide staining = 2mm thick, gray rd purple (SRP 4/2) to velvety rd purple (SRP 3/2)	
#100 388- 392	388		10)	10) Sand, mlt rock (250 to 5000+) 410+ well sorted, med pink (5Y 7/4), submed round, mica: common to plentiful, d/minerals: rare	
	389				
	390			No Recovery	
	391				
#101 392- 392.7	392		11)	11) Sand, mlt rock (250 to 2000+) pebbles (15% 5 to 7mm thick) poorly sorted, pale subbrown (10YR 4/2), subang, d/minerals: common	
#102 392.7- 395	393		12)	12) clay, pale gray (10Y 8/2) = 30mm thick, iron oxide cementation c base of clay = 10 to 15mm thick	
	394		13)	13) clayey sand, mlt rock (350 to 2000+) pebbles (10% 4 to 6mm thick) poorly sorted	
#103 395- 397	395		14)	14) Sand, clt to vel (500 to 1410+, 2000+) pebbles (5% up to 30mm of run, 3 to 6mm thick) med sorted, off white (L4) to pale gray (10YR 8/2), d/minerals: common to plentiful alternating clayey sand, clean sand & iron oxide staining laminae 3 to 2mm thick	
	396		15)	15) iron oxide staining = 50mm thick, med brown (5YR 4/4) to dark brown (5YR 3/2) grades into:	
	397		16)	16) Sand, mlt to clt (350 to 1000+) med to well sorted, off white (L4) to pale gray (10YR 8/2), submed	
	398		17)	17) Sand, mlt to clt (350 to 1000+, 8000+) poorly sorted, subang to submed, d/minerals: plentiful	
	399		18)	18) iron oxide cemented laminae = 10mm thick velvety rd purple (SRP 3/2)	
#104 399- 401	400		19)	19) clayey micaceous sand, mlt to clt (250 to 710+) med to well sorted, pale gray (10YR 8/2), subang to submed, mica: abundant, d/minerals: common clay (10%)	
				grades into: clayey micaceous sand, flt rock (125 to 350+) well sorted, subang grades into: clayey sand/sandy clay, micaceous, sand flt rock (125 to 250+) well sorted	
				micaceous sand, flt rock (125 to 350+) well sorted, pale gray (10Y 8/2), ang ro subang, mica: abundant, d/minerals: common clay (5%) raly texture	
				bedding of alternating laminae of clean sand, clayey sand, micaceous sand = 5 to 7mm thick	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 21 OF
WELL NO. 6C3-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	400			as described above	
#105 401-404	401		400.9	* iron oxide staining ± 5mm thick, mod brown (5YR 3/4)	
	402			1) micaceous sand, ml to mlt (250 to 500 μ) well sorted, off white (W9) to pale gray (10Y 8/2), any to subang, mica: plentiful to abundant, dh minerals: common	
	403			numerous alternating laminae of * iron oxide staining [ultra red (5R 3/6) to dusky red purple (5RP 3/2)], clean sand, clayey sand → laminae ± 3 to 1mm thick	
#106 404-407	404		403.9	2) micaceous sand, fl to ml (177 to 350 μ) well sorted, off white (W9) to gray (5Y 8/1), any, mica: abundant, dh mineral streak laminae w alternating clayey sand & clean sand + iron oxide staining	
	405			3) micaceous sand, fl to ml (177 to 350 μ) well sorted, off white (W9) to gray (5Y 8/1), subang to submed, mica: abundant, dh minerals: common alternating clayey sand (mod gray 5Y 7/6) & clean sand grades into:	
	406			* iron oxide cemented laminae ± 5mm thick, dusky red (10R 3/2)	
#107 407-408	407			4) heavy iron oxide stained sand, ml to cl (250 to 710 μ) well sorted, mod brown (10R 4/6) to gray (5Y 8/2) to dusky purple (5P 3/2), any, mica: common to plentiful, dh minerals: common - sticky contact to	
#108 408-411.2	408		407.4	5) sandy micaceous clay, pale gray (10Y 8/2)	
	409			6) sandy clay ± 20mm thick, off white, grades into: sand, cl to silt (710 to 2000 μ) pebbles (30%, 3 to 5mm thick) parting to, subang	
	410		407.5	7) micaceous sand, fl to flt (25 to 250 μ) well sorted, gray (5Y 8/6), any, mica: abundant, dh minerals: rare, clay (2%) clayey to	
#109 411.2-412.5	411			8) clay, ul light gray (W8), w laminae of sand (cl to flt) into mottled clay gray red purple (5RP 4/2) & dusky red purple (5RP 3/2)	
#110 411.5-412.5	412		100%	clay w sand: common, red to clt (1000 to 2000 μ) any, pink gray (5YR 8/1)	
#111 412.5-416	413		100%	clay, mottled, w sand: common (cl to clt) any, mottled w pale red purple (5RP 4/2) & gray red purple (5RP 4/2) & pink gray (5YR 8/1)	
	414			clay, mottled w sand as described above	
	415			increase in sand content	
#112 416-420	416		415.7	± 415.2 sandy clay, mottled sand (40% cl to clt (500 to 1000 μ & 1410 μ) mod sorted, any, mottled w pale red purple (5RP 4/2) & gray red purple (5RP 4/2), w dusky red purple (5RP 3/2)	
	417			micaceous sandy clay, pink gray (5YR 8/1) & pale red (5RP 3/2) sand, ml to cl (250 to 710 μ) mod sorted, any, mica: abundant grades into:	
	418			clay content decreases	
	419			micaceous clayey sand, ml to cl (250 to 710 μ & 2000 μ), clay (20%) clayey to	
	420		419.7		

FIELD GEOLOGIC LOG

PROJECT	DATE	SHEET 22 OF
WELL NO. 6C13-3	REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY	SRP COORDINATES	DILLER
	COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
#113 420-425	420		0	1) micaceous sand, cl to ucl (500 to 2000+) poorly to mod sorted, off white (5Y) to pale gray (10Y 8/2), any mica abundant, sh minerals common, clay (2%) silty texture	
	421		3)	2) iron oxide cemented laminae ≈ 10 mm thick, rusty red purple (5R 3/4)	
	422		3)	3) micaceous sand, fcl to ucl (100 to 350+) well sorted, off white (5Y) to pale gray (10Y 8/2), any grades into: micaceous sand, ml to ucl (350 to 2000+) poorly sorted, any, mica abundant & shales ≈ 3 mm, sh minerals common	
	423		422.6	4) clay, micaceous w sand (fcl), gray (5Y 1/1), top of clay bed ≈ 2 mm thick, pebbles ≈ 3 to 5 mm thick, subang. LS ≈ 10 mm thick	
	424			5) micaceous sand, ml to ucl (350 to 1000+) mod to well sorted, mod gray (5Y 7/6) to pale gray (10Y 8/2), any, mica abundant alternating clayey sand (mod gray) & clean sand, & iron oxide cemented laminae ≈ 4 mm thick mod brown (5YR 3/4)	
#114	425			6) micaceous sand, as above w increase in sand size ucl (1410+)	
	426			micaceous sand, ml to ucl (250 to 710+) mod to well sorted, mod gray (5Y 7/6) to pale gray (10Y 8/2), any alternating laminae of clay sand (mod gray), & clean sand & coarser sand, ucl to ucl (1000 to 2000+) well sorted, subang.	
#115 427-430	427		426.7	7) micaceous sand, same as described above grades down into: pebbles ≈ 5 to 7 mm thick w above sand on top of iron oxide	
	428		427	8) iron oxide staining ≈ 25 mm thick w cemented laminae ≈ 5 mm thick in center of zone, mod brown (5YR 4/4)	
	429		427	9) micaceous sand, cl to ucl (500 to 1410+) mod sorted, any, clay (5%) silty & iron oxide staining ≈ 15 mm thick, mod brown (5YR 4/4)	
#116 430-433	430			10) micaceous sand, cl to ucl (500 to 1410 to 2000+) mod sorted; subang to subround clay (4%)	
	431		9)	11) micaceous sand, ml to ucl (250 to 1000 to 1410+) mod sorted, any to subang grades into:	
	432		10)	12) sand, ucl to ucl (1000 to 2000+) pebbles (5 to 10%, 3 to 5 mm thick) mod sorted, any to subang	
	433		11)	13) micaceous sand, ml to ucl (350 to 1000+) mod to well sorted, mod gray (5Y 7/6) to pale gray (10Y 8/2), any, numerous alternating laminae ≈ 2 mm thick of clean sand, clayey sand (mod gray) & iron oxide stained sand, purple (5YR 4/2)	
#117 433-436	433		432.9	grades into: cleaner iron oxide stained sand ≈ 7 mm thick & base of staining cemented laminae ≈ 5 mm thick, gray purple (5YR 4/2); 12) sand w clay cl to ucl (710 to 2000+) pebbles (10% 3 to 5 mm thick) poorly sorted, subang	
	434		433	13) Sand, cl to ucl (710 to 2000+) granules & pebbles (15% 2 to 3 mm thick) poorly to mod sorted, gray to pink (5YR 7/2) subang to subround, sh minerals common	
	435		435.4	14) iron oxide staining ≈ 9 mm thick w cemented laminae ≈ 20 mm thick, rusty red purple (5YR 3/6)	
#118 436-438	436			15) iron oxide staining ≈ 4 mm thick, rusty red purple (5YR 3/6) & iron oxide staining ≈ 15 mm thick, rusty red purple (5YR 2/2)	
	437			16) clayey sand, ml to ucl (350 to 710+) mod sorted, gray (5Y 7/6), subang, sh minerals common, clay (20%)	
#117 438-441	438		437.2	17) clayey sand, ml to ucl (350 to 1410 to 2000+) pebbles (25% well ind, 10 to 15 mm thick) poorly to mod sorted, v pale gray (10Y 8/2) sh minerals common to plentiful, clay (20%)	
	439			18) clay sand, ml to ucl (350 to 2000+) poorly sorted, any 19) clay w sand, any gray (5Y 7/6)	
	440			micaceous sand, ml to ucl (350 to 1410 to 2000+), poorly to mod sorted, mod gray (5Y 7/6) to pale gray (10Y 8/2), any to subang, mica abundant, sh minerals common & plentiful, clay (20%) silty texture	
	441			alternating laminae of clayey sand (mod gray) & clean sand & coarser (pebbles) sand (5 mm thick) well sorted, subang to subround LS from 0.2 to 5 mm thick also numerous sh mineral laminae	

alternating clayey laminae ≈ 3 mm thick (pebbles 5 to 7 mm thick, well sorted)

FIELD GEOLOGIC LOG

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WELL NO. 6413-3	SRP COORDINATES	DRILLER	
LOGGED BY	COMPANY	DRILLING METHOD	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	440			as described above	
#120 441-445	441		440.5	1) clayey sand, cl to ucl (500 to 1410) med well sorted, off white (U9) to pale gray (U10 1/2), any to subang, mica abundant, clay (15%) clay texture clay laminae = 10mm thick, clay ball = 1/4" 5 = 10mm in diameter grades into:	
	442		2) 3) 4)	2) clean sand, cl to ucl (500 to 1000) well sorted, off white (U9) subang, mica abundant grades into:	
	443		5)	3) clayey sand, cl to ucl (710 to 8000) pebbles (20% 3 to 5 mm thick) poorly sorted, gray (5Y 4/4), any to subang, dh minerals: common, clay (80%) clay texture	
	444			4) clayey sand, gray, laminae = 3mm thick iron oxide staining = 2mm thick of sand ucl (140-2000) in contact with clay	
#121 445-449	445		444.6	5) micaceous sand, m to ucl (350 to 710) med well sorted, off white (U9) to gray (5Y 4/4), any, mica abundant, numerous alternating laminae = 2 to 4 mm thick of clayey sand and clean sand, dh minerals, iron oxide staining grades into:	
	446		7) 8)	6) clay sand, m to ucl (250 to 1410, 2000) poorly sorted, subang, w pebbles (5% 10 to 15 mm thick, well sorted)	
	447		9) 10)	7) clay sand, m to ucl (250 to 1410, 2000) pebbles (5% 5 to 10 mm thick well sorted) poorly sorted, off white (U9), subang, dh minerals: common, clay (20%) grades into:	
#122 448-453	448		447.6	8) sand, m to ucl (250 to 1000, 2000) pebbles (5% 3 to 5 mm thick) poorly to med sorted, off white (U9), any to subang, dh minerals: common, mica common, clay (5 to 10%) clay texture grades into	
	449			9) micaceous sand, fl to ucl (25 to 250) well sorted, gray (5Y 4/4), any, mica abundant, alternating clayey sand & w micaceous sand, iron oxide stained laminae = 2 to 4 mm thick, clay (10 to 15%) clay texture grades into:	
	450		450.1	10) micaceous sand, m to ucl (250 to 710) med well sorted, subang, mica abundant, clay (10%) clay	
	451			silty clay, gray (5Y 4/4) w streaked gray (5Y 3/4), some interbedded clayey sand laminae = 2 to 5 mm thick, cl to ucl (500 to 1410, 2000) pebbles (5% 5 to 10 mm thick, well sorted) any	
#123 453-455	453		11) 12)		
	454		13)	11) silty clay, gray (5Y 4/4) w 10mm thick sand laminae (clean) cl to ucl (710 to 2000) any	
#124 455-458	455		454.6	12) micaceous, clayey sand, fa to mll (100 to 500) well sorted up to ang (OYR 1/2), any, mica abundant, clay (5%) iron oxide staining laminae (clean sand) gray to purple (5RP 4/2) w dusky rd purple (5RP 3/2)	
	456		14)	13) clay, mottled, gray (5Y 4/4) w dusky rd (5R 3/4)	
	457		15)	14) clay, mottled, gray (5Y 4/4) w dusky rd (5R 3/4) w sand (5 to 10 ucl to ucl (1000 to 2000) any	
#125 458-461	458		457.5	15) micaceous, silty clay, gray (5Y 4/4) * iron oxide stained laminae = 5mm thick w dusky rd purple (5RP 3/2)	
	459		16)	micaceous clay, gray (5Y 4/4) w some dense clay ending w adense clay = 20mm thick in contact w	
	460		457.5	16) clayey sand, m to ucl (250 to 710) pebbles (10%, 2 to 4 mm thick) med sorted, any, off white (U9)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 24 OF
WELL NO. GC13-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	46.0				
	46.1			1) micaceous sand, fll (177 to 250 v) well sorted, yggy (57%) w/ pale red purple (SRP 1/2), any dh minerals: common mica abundant, clay (15 to 20%) clay matrix	
	46.2		2)	* iron oxide staining = 20mm thick, mod yggy (57%) w/ dusky red purple (SRP 3/2)	
	46.3		3)	2) Sand, ch to ck (500 to 1000 to 2000 v) pebbles (5%, 2 to 5mm thick) mod sorted, pale pink (SRP 3/2) numerous thin iron oxide staining laminae = 5mm thick	
	46.4		46.3.3	* interbedded clay = 5mm thick yggy 54 1/2	
	46.5			3) clay, yggy (54 1/2)	
	46.6			micaceous sand, mlt to vcl (350 to 2000 v) poorly sorted, off white (10%) to pale yggy (10 1/2%), subang, mica abundant, dh minerals: common, clay (5 to 10%)	
	46.7			alternating laminae = 2 to 10mm thick of clayey sand, clean sand, iron oxide stained	
	46.8		46.7.2		
	46.9				
	47.0		4)	1) micaceous sand, ch to vcl (500 to 2000 v) poorly to mod sorted, any to subang, clay (10 to 15%)	
	47.1		5)	* iron oxide staining laminae = 10mm thick, iron stained sand, pebbles (20% 3 to 5mm thick)	
	47.2		6)	2) clay laminae = 3mm thick, yggy (54 1/2), staining mod yggy 54 1/2 to base of lamina	
	47.3		7)	3) micaceous sand, ch to vcl (500 to 1410 v) poorly to mod sorted, subang, clay (10 to 15%) grades into: pebble sand, = 4mm thick = 470' pebbles (15%, 5 to 20mm thick) subang to mod, iron oxide staining through sand pebble lag, dk yggy (10 1/2 1/2), dh minerals: common to plentiful	
	47.4		47.2.3	7) cycle in run: micaceous sand, mlt to vcl (350 to 1410 v) mod sorted, off white (10%) to mod yggy (54 1/2%), any to subang, clay (10 to 15%) clay, grades into: pebble sand = 7mm thick = 475' pebbles (15% 3 to 12mm thick)	
	47.5		8)	8) Sand to clay, ch to vcl (710 to 2000 v) poorly to mod sorted, off white (10%), subang, clay (15%), clay laminae = 4mm thick	
	47.6		9)	9) below clay lamina, pebble lag w/ clay = 6mm thick, pebbles (25%, 5 to 15mm thick, mod) clay (20%)	
	47.7		10)	10) Sand, fll to mlt (177 to 300 v) well sorted, yggy (10 1/2 1/2) to off white (10%), any to subang, mica: plentiful, dh minerals: plentiful to abundant + iron oxide staining = 7mm thick, dusky red purple (SRP 3/2) grades into: = 474.9' sand, mlt to vcl (250 to 710 v, 1000 v) mod sorted, subang to subred	
	47.8		11)	11) Sand, mlt to vcl (350 to 1000 v) mod mod sorted, yggy (10 1/2 1/2) to off white (10%) any to subang + iron oxide staining = 3mm thick, dusky red purple (SRP 3/2)	
	47.9		12)	12) Sand, mlt to vcl (350 to 1410 v) poorly to mod sorted, off white (10%) to pale pink (SRP 1/2), subang mica: common, dh minerals: common to plentiful	
	48.0		47.9.2	numerous alternating laminae of clean sand, clayey sand, iron oxide staining = 2 to 10mm thick	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 25 OF
WELL NO. GCB-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DILLER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#131 480- 485	480			1) Sand, ml to ml (250 to 500+) well sorted, off white (10YR 7/4), subang grades into: sand, ml to vch (350 to 1410+) und sorted, subang to subnd = 481.5'	
	481		1)	alternating laminae of clay sand, off white (10YR 7/4), to clean sand	
	482		2)	* iron oxide staining = hematite, dusky red purple (5R 3/2) grades into:	
	483		3)	2) sand, ml to pl (350 to 710+, 1410+) well sorted, gray (10YR 7/4), ang to subang, dhminerals: common	
	484		4)	thin clay laminae = 483 = 10 mm thick	
	485		483.7	3) sand, cl to vch (500 to 1410+) poorly to mod sorted, subang to subnd, dhminerals: common	
	486		100%	4) clay w/ interbedded sand, clay, ggy (5Y 7/2), sand clay, cl mch (500 to 1000+, 2000+) poorly sorted, subang	
#132 485- 485.4	485			clay, ggy (5Y 7/2), mottled w/ mod rd (5R 4/6)	
#133 485.4- 492	486			clay, mottled, ggy (5Y 7/2) w/ mod rd (5R 4/6) grades into:	
	487			= 486.5' sandy clay, sand ml to sh (350 to 710+) then grades back into:	
	488			= 487' silty clay grades into:	
	489				
	490		450.1	= 489.6' sand clay, bottom 2m well indurated → siltstone to sandstone → well cemented	
	491				
#134 492- 493.2	492			5) Sand, ml to cl (250 to 1000+, 2000+) mod to well sorted, ggy (10YR 7/4), ang to subang, mica: common	
	493		492.8	dhminerals: rare grades into:	
#135 493.2- 495	493		493.4	6) Sand, cl to vch (500 to 1410+, 2000+) mod sorted, ggy (10YR 7/4) to mod yw brown (10YR 5/4), subang to subnd	
	494			dhminerals: common, mica: rare to common	
#136 495- 498	495			7) Sand w/ clay, ml to cl (350 to 1000+ & 1410+) poorly to mod sorted, mod yw brown (10YR 5/4), subang to subnd, clay (20 to 25%)	
	496		8)	8) Sand, ml to cl (250 to 710+, 1000+) mod sorted, off white (10YR 7/4), subang to subnd, dhminerals: common	
	497		9)	mica: rare, clay (5%) thin clay laminae = 496 = 5 mm thick, off white (10YR 7/4) = 10° off horizontal	
	498		9)	9) Sand, ml to cl (250 to 710+) mod to well sorted, mod yw brown (10YR 5/4), ang to subang, grades into: sand fl to ml (177 to 350+) well sorted, mod yw brown (10YR 5/4), subang to subnd, dhminerals: plentiful	
#137 498- 499.5	498		497.6	* iron oxide staining lamina = 5 mm thick, mod brown (5YR 3/4)	
	499		499.4	10) Sand, fl to ml (177 to 500+) well sorted, mod yw brown (10YR 5/4), subnd to rd, dhminerals: plentiful (silt sand)	
#138 499.5- 503	500			Sand, fl to ml (177 to 500+), as above, since clayey sand laminae = 499.2 = 7 to 10 mm thick	
				described on sheet 26	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 26 OF
WELL NO. G613-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#139 503-505	500		1)	Sand, flint rock (177 to 500 ft) grades into: = 500' sand, ml to sl (250 to 710 ft) pebbles (10% 3 to 5 mm thick)	
	501		2)	any to subang. dminerals: common to plentiful, clay (10%) this interval = 20 mm thick, increases below.	
	502		3)	Sand, flint rock (177 to 710 ft, 1000 ft) partly to med sorted, mod grey brown (10YR 5/4), any to subang. dminerals: common to plentiful, grades into: sand, ml to sl (350 to 1000 ft, 1410 ft) med sorted, subang, dminerals: plentiful	
	503		4)	grades into: sand, ch rock (177 to 2000 ft) pebbles (25% 3 to 7 mm thick) poorly sorted, any to subang.	
	504		5)	Sand, ml to rock (250 to 500 ft, 710 ft) well sorted, any to subang (10YR 7/4) to mod grey brown (10YR 5/4), subang, dminerals: common, grades into: sand, ch rock (500 to 1000 ft, 1410 ft) med sorted, any to subang.	
#141 505-509	505		6)	Sand, ml to rock (350 to 1000 ft, 1410 ft) med sorted, mod grey brown (10YR 5/4), any to subang, dminerals: common, clay (5%)	
	506			* iron oxide cemented laminae = 10 mm thick, yellowish (10R 3/2)	
	507			5) Sand, ml to rock (350 to 2000 ft) pebbles (5 to 10%, 5 to 10 mm thick, med) poorly sorted, mod grey brown (10YR 5/4), subang to submed, dminerals: common, clay (2%)	
	508			No Recovery	
	509				
#142 509-511	510		6)	Sand, ch to vel (500 to 1410 ft) pebbles (5% 3 to 5 mm thick), poorly to med sorted, grey brown (10YR 5/4) to mod grey brown (10YR 5/4), any to subang, dminerals: common, clay (5%)	
	511		7)	* iron oxide staining = 3 mm thick, yellowish, red purple (10R 3/2)	
	512		8)	Sand, ml to rock (350 to 2000 ft) pebbles (20% 3 to 5 mm thick) poorly sorted, mod grey brown (10YR 5/4), subang, dminerals: plentiful, grades into: sand, flint rock (177 to 710 ft), med sorted, mod grey (5YR 7/6), subang, clay (5%)	
	513			clay, mottled, grey pink (5YR 7/2) to pale grey brown (10YR 5/4) in pale yellow (10YR 7/6), mod rd (5YR 5/4)	
	514				
#143 511-512	515		9)	Sand, flint (177 to 250 ft, 350 ft) well sorted, any to subang (10YR 7/4), subang to submed, dminerals: common, grades into: * iron oxide staining = 5 to 10 mm thick, some cementation, mod brown (5YR 3/4)	
	516		10)	Sand, ml to rock (250 to 710 ft, 2000 ft) pebbles (5% 3 to 5 mm thick) poorly to med sorted, any to subang, dmin: plentiful, numerous alternating laminae = 2 to 10 mm thick of clean sand, clayey sand	
	517		11)	* iron oxide staining laminae = 10 mm thick, mod brown (5YR 3/4)	
	518		12)	Sand, ml to rock (350 to 1000 ft, 2000 ft) med sorted, flint to ch (yellow sand) to pale grey, pebbles (5% 3 to 5 mm thick)	
	519			any to subang, alternating laminae = 5 to 20 mm thick of clayey sand, clean sand, iron oxide staining	
#145 515-517	520		13)	Sand, ml to rock (250 to 1410 ft) poorly sorted, any to subang (10YR 7/4) to pale grey (10YR 7/6), any to subang, dminerals: common, iron oxide staining = 15 mm thick	
	521		14)	Sand, flint to rock (177 to 350 ft, 1410 ft) med sorted, any to subang (10YR 7/4), subang to submed, clay balls = 10 mm thick	
	522			present, alternating laminae = 2 to 20 mm thick of clayey sand, sand, coarse sand, pebbles (5 to 10 mm thick)	
	523			grades into: sand, flint to rock (177 to 500 ft, 1000 ft) med to well sorted, any to subang	
	524			12) clay, grey pink (5YR 7/2)	
#146 519-523	525			Sand, ch to vel (500 to 1410 ft, 2000 ft) pebbles (5% 3 to 5 mm thick), poorly to med sorted, any to subang (10YR 7/4) any to subang	
	526			grades into: Sand, ml to rock (350 to 1000 ft, 1410 ft) poorly sorted, any to subang	
	527				
	528				
	529				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 27 OF
WELL NO. GC13-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#H7 523-527	520			* iron oxide staining = 6cm thick, concentration = 10mm thick, nod brown (5YR 7/4) to grey (5YR 4/2)	
	521			1) Sand, mlt to vll (250 to 500 or 8000 or) mod sorted, grey (10YR 7/4), subang, Al minerals common, grades into: e 520.5 sand, fl to mlt (170 to 500 or, 1000 or) mod sorted, grey	
	522			* iron oxide staining = 4cm thick, concentration = 1mm thick, light brown (5YR 5/6) to nod brown (5YR 7/4)	
	523		523.8	2) Sand, fl to vll (170 to 350 or) well sorted, grey (10YR 7/4), subang to submed, Al minerals common, grades into: Sand mlt to vll (350 to 1410 or, 8000 or) poorly to mod sorted, grey to subang, clay (5%)	
	524			3) Sand, vll to vll (350 to 1410 or) as above	
#148 527-532	525			4) clayey sand, mlt to vll (350 to 1200 or, 1410 or) pebbles (5% 3 to 5mm thick) ang, to subang, clay (30 to 80%)	
	526		526.2	Al minerals common, off white (L5) to grey (5YR 7/2), some clay balls = 2 to 5mm diam.	
	527			5) Sand, cl to vll (350 to 800 or) pebbles (10% 3 to 5mm thick) poorly sorted, grey (10YR 7/4), subang	
	528			numerous thin laminae = 2 to 10mm thick, clay, grey (5YR 7/2) clayey sand, pebble sand, clean sand	
	529			* iron oxide staining = 6cm thick, v. dusky rd (10R 7/2)	
#149 532-536	530			* iron oxide staining = 10cm thick, concentration = 3.5mm thick, nod brown (5YR 7/4)	
	531				
	532			6) Sand, cl to vll (500 to 2000 or) pebbles (2% 5 to 10mm thick) poorly sorted, ang to subang, grey (10YR 7/4)	
	533			numerous thin laminae = 2 to 5mm thick & iron oxide staining = 5cm, v. dk rd (5R 7/6) to v. dk rd purple (5R 7/2)	
	534			* iron oxide staining = 3cm thick, concentration on top = 4mm thick, v. dusky purple (5R 7/2)	
#150 536-540	535			* clayey sand, off white (L5)	
	536			7) Sand, mlt to vll (350 to 1410 or) poorly sorted, mod yellow (10YR 5/4), subang	some thin clay laminae = 2 to 10mm thick
	537				
	538			* iron oxide staining = 4cm thick, concentration = 5mm thick, v. dusky rd (10R 7/2)	
	539			8) clayey sand, cl to vll (500 to 2000 or) pebbles (20% 3 to 4mm thick) poorly sorted; off white (L5) to v. pale (10YR 7/2)	
	540			subang, mica: plentiful, Al minerals: rare, clay (40%) to clay texture, clay balls	
				9) interbedded clay laminae = 4cm thick, v. pale (10YR 7/2)	
				10) Sand, cl to vll (500 to 2000 or) pebbles (5% 3 to 5mm thick) mod sorted, grey (10YR 7/4) subang to submed	
				some thin clayey sand laminae = 2 to 5mm thick	
				11) Sand, cl to vll (500 to 2000 or) pebbles (20% 3 to 5mm thick) poorly sorted, subang, Al minerals common	
				clay (10%)	
				12) micaceous sand, fl to vll (170 to 710 or) mod sorted, v. pale (10YR 8/4) ang to subang, mica: abundant, Al minerals: common	
				clay (5%) clay texture + iron oxide staining = 5cm thick, v. dk rd (5R 7/6)	
				13) Sand, cl to vll (710 to 2000 or) pebbles (10% 2 to 8mm thick) poorly to mod sorted	off white (L5) to v. pale (10YR 7/2), ang to subang, clay (25%) mica: common, grades into: pebble sand, pebbles (10% 10mm thick, end)
				14) micaceous sand, fl to vll (170 to 500 or) well sorted, off white (L5), subang to ang, clay (5%)	
				grades into: micaceous sand, fl to vll (170 to 1410 or, 8000 or) poorly sorted, ang to subang, clay (10%)	
				15) Sand, cl to vll (500 to 2000 or) pebbles (10% 3 to 7mm thick) poorly sorted, ang to subang, cl (20%)	
				grades into: pebble gravel & rapid underlying clay (60% 5 to 10mm thick, end)	
				16) clay, v. pale (10YR 8/2)	

FIELD GEOLOGIC LOG

PROJECT		DATE		SHEET	
				28	OF
WELL NO.		SRP COORDINATES		DRILLING CONTRACTOR	
6C13-3					
LOGGED BY		COMPANY		DRILLING METHOD	
RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#151 540-542	54.0		1)	1) Sand, ml to cl (350 to 1000 ϕ , 2000 ϕ) poorly to med sorted, off white (W) to upale org (10YR 5/2) any to subang, clay (30 to 40%), clay laminar $\approx$ 540.3' $\approx$ 10mm thick, gray org, pink (5YR 7/2), clay balls	
#152 542-547	54.1		2)	2) Sand, fl to ml (177 to 500 ϕ) well sorted, dk gray org (10YR 4/6), subang to med, mica: plentiful, * iron oxide staining $\approx$ 3mm thick, med brown (5YR 3/4)	
	54.2		541.2'		
	54.3		3)	3) Sand, cl to ucl (710 to 2000 ϕ) pebbles (5 to 3mm thick) poorly to med sorted, med gray brown (10YR 5/4), subang to submed, clay (5%), numerous thin clayey sand laminae $\approx$ 5mm thick, grades into: $\approx$ 543'	
	54.4		4)	pebble sand, fl to ucl (710 to 2000 ϕ) pebbles (6 to 10mm thick) poorly sorted, any to subang, grades into: $\approx$ 543.5' sand, cl to ucl (500 to 2000 ϕ) pebbles (10 to 3 to 5mm thick) med sorted, any, dk minerals: common	
	54.5		5)	4) silty clay, gray (5Y 7/2), iron oxide staining $\approx$ top of clay $\approx$ 2mm thick, dusky rd (5Y 3/6) w med gray (5Y 7/6)	
	54.6		545	5) pebble laminae $\approx$ 2mm thick (3 to 7mm thick) any to subang, grades into: sand, cl to ucl (710 to 1410 ϕ , 2000 ϕ) med sorted, off white (W), subang to submed, dk minerals: rare to common clay (5%)	
#153 547-552.5	54.7		6)	6) Sand, ml to cl (350 to 1000 ϕ), med sorted, upale org (10YR 5/2), any to subang, mica: plentiful, dk minerals: common	
	54.8		7)	clay (5%) grades into: 7) Sand, cl to ucl (710 to 2000 ϕ) pebbles (30 to 3 to 5mm thick) med sorted, off white (W) to upale org (10YR 5/2), subang, mica: common, clay (15 to 20%), which concentrations of dk minerals $\approx$ 15mm thick	
	54.9		8)	8) clay laminae $\approx$ 2mm thick, upale org (10YR 5/2)	
	55.0		9)	9) Sand, fl to ml (177 to 350 ϕ) well sorted, off white (W) to gray (5Y 7/2), subang to submed, dk minerals: rare to common	
	55.1		551.5'	semi indurated from 549.5 to 550.3' * iron oxide staining $\approx$ 10mm thick, dusky rd purple (5R 3/2)	
#154 552.5-558	55.2		552.5'		
	55.3		10)	10) Sand, fl to ml (177 to 350 ϕ) well sorted, off white (W) subang to med, mica: common, dk minerals: plentiful, * iron oxide staining $\approx$ 4mm thick, gray rd purple (5R 4/2) w dusky rd purple (5R 3/2)	
	55.4		11)	11) Sand, ml to cl (250 to 710 ϕ , 1000 ϕ) well sorted, off white (W), subang to submed, dk minerals: common grades in: * iron oxide staining $\approx$ 5mm thick, dusky rd purple (5R 3/2)	
	55.5		12)	$\approx$ 554.5' sand, ml to cl (250 to 710 ϕ , 1410 ϕ , 2000 ϕ) pebbles (2 to 3mm thick) med sorted, off white (W) to upale org (10YR 5/2) subang to submed, dk minerals: common	
	55.6		13)	12) iron oxide staining $\approx$ 7mm thick, dusky rd purple (5R 3/2)	
	55.7		13)	13) Sand, ml to ml (250 to 500 ϕ) well sorted, gray org (10YR 7/4), subang to submed grades into: Sand, ml to ucl (350 to 1410 ϕ) med sorted, any to subang, * iron oxide concentration $\approx$ 6mm thick, med brown (5YR 3/4)	
#155 558-560	55.8		558.6'	13) Sand, cl to ucl (500 to 2000 ϕ) pebbles (2 to 5 to 3mm thick) poorly sorted, any to subang	
	55.9		558.6'	Sand, ml to cl (350 to 1000 ϕ) med to well sorted, gray org (10YR 7/4), subang, dk minerals: common	
	56.0			* iron oxide staining $\approx$ 7mm thick, some cementation, dusky rd purple (5R 3/2)	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 29 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#156 566-566	56.0			1) Sand, ultra well (710 to 2000w) pebbles (15%, 3 to 7mm thick) poorly rounded sorted, gray org (10YR 7/4) subang.	
	56.1			dhminerals common	
	56.2			* iron oxide staining = 10mm thick, some cementation, mod brown (5YR 3/4)	
	56.3			2) Sand, ultra well (500 to 2000w) pebbles (25%, 3 to 10mm thick) poorly sorted, gray org (10YR 7/4) subang.	
				dhminerals common, some thin laminae = 7 to 10mm thick of clayey sand (off white (2.5)) to iron	
				oxide staining (mod brown (5YR 3/4))	
	56.4		56.3.1	3) clayey sand, ultra well (500 to 2000w) pebbles (15% 3 to 7mm thick) poorly sorted, off white,	
				subang to subround, mica common, clay (30 to 40%) tabular texture	
	56.5				
	56.6				
#156A 566-572	56.7			4) Sand, ultra well (350 to 1410 or 2000w) pebbles (2 to 5%, 3 to 7mm thick) poorly rounded sorted, off white (2.5),	
				any no subang, dhminerals common, clay (2 to 5%) grades into:	
	56.8			5) Sand, ultra well (500 to 2000w) pebbles (40 to 50%, 3 to 10mm thick) poorly sorted, upale org (10YR 8/2)	
				subang dhminerals common, thin clay laminae = 10 to 20mm thick, off white (2.5), clay balls	
				6) iron oxide staining = 3mm thick, cementation = 10mm thick, mod brown (5YR 3/4)	
	56.9			* iron oxide staining = 10mm thick, mod brown (5YR 3/4)	
	57.0			6) Sand, ultra well (350 to 1410 or 2000w) poorly rounded sorted, off white (2.5), subang, dhminerals common	
				clay (5%) c 56.9.1 pebble lag = 2cm thick, pebbles (10% 5 to 10mm thick) subround to round	
	57.1		57.0.3	7) Sand, ultra well (350 to 1000w, 410w) well sorted, mod yellow brown (10YR 5/4), subang to subround	
				dhminerals common, clay balls = 5 to 10mm in diameter	
	57.2				
#157 572-576	57.3			1) clay streaks / sand, upale org (10YR 8/2), sand, fine (125 to 250w) well sorted, upale org (10YR 8/2), any no subang, clay (20	
				2) clay interbedded w sand, clay = 5 to 15mm thick, upale org (10YR 8/2), sand, ultra well (350 to 2000w)	
				poorly rounded sorted, upale org (10YR 8/2) to gray org (10YR 7/4), any no subang, dhminerals, some	
				clayey sand laminae present.	
	57.4			3) Sand, ultra well (350 to 2000w) pebbles (40%, 3 to 5mm thick) poorly sorted, mod yellow brown (10YR 5/4), subang	subround,
			57.4.4	dhminerals common grades into:	
	57.5			4) Sand, ultra well (500 to 2000w) pebbles (5 to 10%, 3mm thick) mod sorted, mod yellow brown (10YR 5/4), any no subang.	
				top of lam #4 = 57.3' high concentration of dhminerals + clay (10%)	
#158 576-585	57.6				
	57.7				
	57.8			No Recovery	
	57.9				
	58.0				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 30 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	58.0				
	58.1			No Recovery	Top of Cape Fear? From 576-585
	58.2				
	58.3				
	58.4				
	58.5				
#159 585-589	58.6		1)	1) Sand, mltrach (350 to 1000 & 2000) mod sorted, mottled, off white (U9), pale rd purple (SRP 4/2), gray purple (SP 4/2) subang, mica: plentiful abundant, clay (10 to 15%) grades into:	
	58.7			= 586' pebble sand, sand mltrach (350 to 2000) poorly sorted, any to subang, gray rd purple (SRP 4/2) any to subang, clay (5%), pebbles (30%, 10 to 30 mm thick) rd to well end	
	58.8		2)	2) Sand, mltrach (350 to 1410) mod sorted, pale pink (SRP 8/2) to mod rd (SR 5/4), off white (U9), subang to rd, clay (2 to 5%) grades into	
#160 589-592	58.9		3)	Sand, chl rch (500 to 2000) poorly sorted, any to subang, pale rd purple (SRP 4/2) to gray rd purple (SRP 4/2) grades into: pebble sand = 588.6, sand, chl rch (500 to 2000) as above, pebbles (30%, 3 to 20 mm thick) rd to well end	
	59.0		4)	3) Sandstone, sand, fl rch (125 to 250) well sorted, off white (U9) to gray rd purple (SRP 4/2), subang, mica: common, dm minerals: common, in contact with	
#161 592-595	59.1		5)	4) Sand & clay, fl rch (177 to 500 & 1000) well sorted, pale pink (SRP 8/2) to pale rd purple (SRP 4/2), subang to rd, mica: common, clay (20 to 25%) grades into: sand, mltrach (350 to 1000) poorly sorted, any to subang, clay (10%) grades into: sand, mltrach (350 to 1000) mod sorted, subang, clay (10%)	
	59.2		6)	5) Sand, chl rch (500 to 2000) pebbles (10%, 3 to 5 mm thick) poorly to mod sorted, gray rd purple (SRP 4/2), well indurated; subang to rd, clay (10%) grades into: sand, mltrach (350 to 1000) mod sorted, subang, clay (10%)	
	59.3		7)	6) clayey sand, mltrach (350 to 1000) mod sorted, gray rd purple (SRP 4/2), subang, mod to well indurated, grades into: = 594' clayey sand, mltrach (350 to 2000) pebbles (20% 3 to 10 mm thick) poorly sorted, gray rd purple (SRP 4/2) to dusky rd purple (SRP 3/2), any to subang, clay (5%), mod indurated, grades into:	
#162 595-597.8	59.4		8)	pebbles sand, sand, mltrach (350 to 2000) as above, pebbles (50% 3 to 10 mm thick) rd, clay (30%) mod indurated	
	59.5		9)	7) Sand & clay, mltrach (350 to 1000 & 1410) mod sorted, any to subang, clay (20%), well indurated	
	59.6		10)	8) Sand & clay, mottled due to iron oxide staining, sand, chl rch (500 to 1410 & 2000) mod sorted, pale rd purple (SRP 4/2), gray rd purple (SRP 4/2), dusky rd purple (SRP 3/2), mod gray (5%), subang, clay (5%) well indurated	
#163 597.8-601	59.7		11)	9) sharp contact, sandy clay, mod light gray (U6) grades into: clay = 597'	
	59.8			? Bottom of Cape Fear	
	59.9			clay, mottled mod light gray (U6), mod gray (U5), mod dk gray (U4), well indurated	
	60.0			sandy clay from 598' to 598.5' sand, mltrach (350 to 1000 & 2000) mod sorted, subang	

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 31 OF
WELL NO. GCB-3		REFERENCE DATUM	DILLING CONTRACTOR
LOGGED BY		SRP COORDINATES	DRIER
		COMPANY	DILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DILLING COMMENTS
	600			clay, well indurated, as described above	
601	601		1)	1) clay, well indurated, med dk gray (U4) grades into:	
602	602		2)	2) Sandstone, sand, fl to fu (125 to 250 to 2000 u) granules (10% 2mm thick), well sorted, med dk gray (U4), subang to subang, sharp contact w:	
603	603		3)	3) clay, well indurated, med dk gray (U4) grades into:	
604	604			clay, mottled 603.5' med dk gray (U4) w med olive brown (5Y 4/4), med yw (5Y 7/6) grades into:	
605	605		4)	4) clay, well indurated, mottled, med olive brown (5Y 4/4), light olive brown (5Y 7/6) w med yw (5Y 7/6) sharp contact w: 5) silty clay, indurated, med gray (U5)	
606	606		5)	5) silty clay, indurated, med gray (U5)	
607	607		6)	6) sandy clay, med light gray (U6), sand, cl to vcl (110 to 2000 u) subang, well indurated, grades into:	
608	608		7)	7) clayey sand, cl to vcl (110 to 2000 u) med sorted, mottled, med rd (5R 4/6) w med rd (10R 4/6) dk yw (10YR 4/6), subang, well indurated, grades into:	
609	609		8)	8) Sand w clay, sand, ml to vcl (350 to 2000 u) pebbles (15 to 20% 3 to 5 mm thick), poorly sorted, med light gray (U6), ang to subang, med indurated, clay (20%) in contact w:	
610	610		9)	9) silty/sandy clay, light gray (U7), sand fl to ml (177 to 350 u), subang, mica: common, indurated, grades into:	
611	611			c = 610.5' sandy, fl to vcl (177 to 110 u) med to well sorted, med light gray (U6), ang to subang clay (10 to 15%), mica: v. com, indurated	
612	612		100%		
613	613		10)	10) Sand, ml to vcl (350 to 1410 u) med sorted, light gray (U7), subang, mica: common, well indurated, clay (5%) grades into	
614	614				
615	615			c = 615' sand ml to vcl (250 to 1000 u) well sorted, light gray (U7) to med light gray (U6), subang well indurated, clay (5%), mica: common	
616	616		11)	11) clay, off white (U9) to bluish white (5B 9/1), well indurated, Saprolite contact c 616	
617	617		100%		
618	618			clay, Saprolite, well indurated, mottled, off white (U9) w bluish white (5B 9/1), pale blue (5PB 7/2) little foliation if any	
619	619			bluish white (5B 9/1) to gray blue gm (5B 6 5/2)	
620	620				

FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET 32 OF
WELL NO. GCB-3		REFERENCE DATUM	DRILLING CONTRACTOR
LOGGED BY		SAP COORDINATES	DRILLER
		COMPANY	DRILLING METHOD

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
#166 620- 621	62.0		100%	slaty, saprolite, well indurated, mottled, bluish white (5B 7/1) to gray blue grn (5B 6 5/2)	
#167 621- 622	62.1			little foliation if any	
	62.2			weathered chlorite schist,	
	62.3			well indurated, foliated, gray blue grn (5B 6 5/2) grades into:	
	62.4			dk yw grn (10G 7 1/4) to dusky green, massive foliation, saprolite,	
	62.5			highly foliated, well indurated, dk yw grn (10G 7 1/2) to dk yw grn (10G 4 3/2)	
	62.6				
	62.7				
#168 628- 631	62.8		62.7-6		
	62.9		100%	e 62.9 weathered chlorite schist	
#168 631- 631.9	63.0			chloritic schist, dusky grn (5G 3 1/2) to dusky blue green (semi weathered)	highly foliated
#169 631.9- 632	63.1			ppr in fracture e 63.1? radiate xls	
	63.2				
	63.3				
	63.4				
	63.5				
	63.6				
	63.7				
	63.8				
	63.9				
	64.0				

Appendix B

Suspension Velocity Measurements for GCB-1 and 2

**Note: GCB-4 and 5, included in this data, are not part
of the AM Study**

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SUSPENSION VELOCITY MEASUREMENTS

AT THE

SAVANNAH RIVER SITE

BOREHOLES GCB-1, GCB-4, AND GCB-5

Prepared for

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INTRODUCTION

Suspension velocity measurements were performed in boreholes GCB-1, GCB-4, and GCB-5 at the Savannah River Site, near Aiken, South Carolina. Suspension P- and S_H -velocity measurements were collected to a maximum depth of 1036.8 ft. Data acquisition was performed on September 4 and 29, 1996. The work was conducted by Rob Steller of Agbabian Associates for the University of South Carolina and the Westinghouse Savannah River Company. Mr. Mike Waddell was the technical liaison for the University of South Carolina, with Mr. Doug Wyatt serving as project liaison for Westinghouse.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of suspension velocity measurements on September 4 and 29, 1996, between depths of 4.9 and 1036.8 ft in the nominal 6 inch uncased boreholes designated GCB-1, GCB-4, and GCB-5, located at the Savannah River Site, near Aiken, South Carolina. The purpose of these measurements was to acquire shear wave velocities and compressional wave velocities as a function of depth which, in turn, will be used to characterize ground response to earthquake motion.

The OYO Model 170 Suspension Logging Recorder and Suspension Logging Probe were used to obtain in-situ horizontal shear and compressional wave velocity measurements at 3.28 intervals. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the velocity measurement techniques used in this study is:

Guidelines for Determining Design Basis Ground Motions, Report TR-102293,
Electric Power Research Institute, Palo Alto, California, November 1993,
Sections 7 and 8.

INSTRUMENTATION

Suspension soil velocity measurements were performed using the Model 170 Suspension Logging system, manufactured by OYO Corporation. This system directly determines the average velocity of a 3.28 ft high segment of the soil column surrounding the borehole of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The geophones that detect the wave, and the source that generates the wave, are moved as a unit in the borehole producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave generator (S_H) and compressional-wave generator (P), joined to two biaxial geophones by a flexible isolation cylinder, as shown in Figure 1. The separation of the two geophones is 3.28 ft, allowing average wave velocity in the region between the geophones to be determined by inversion of the wave travel time between the two geophones. The total length of the probe as used in this survey is approximately 19.0 ft; the center point of the geophones is approximately 12.1 ft above the bottom end of the probe. The probe receives control signals from, and sends the amplified geophone signals to, instrumentation on the surface via an armored 7 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data.

The entire probe is suspended by the cable and centered in the borehole by nylon "whiskers", therefore, source motion is not coupled directly to the borehole walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the borehole and surrounding the source. This pressure wave is converted to P and S_H -waves in the surrounding soil and rock as it impinges upon the borehole wall. These waves propagate through the soil and rock surrounding the borehole, in turn causing a pressure wave to be generated in the fluid surrounding the geophones as the soil waves pass their location.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal geophones situated parallel to the axis of motion of the source are recorded.

2. The source is fired again in the opposite direction and the horizontal geophone signals are recorded.
3. The source is fired again and the vertical geophone signals are recorded. The repeated source pattern facilitates the picking of the P and S_H -wave arrivals; reversal of the source changes the polarity of the S_H -wave pattern but not the P-wave pattern.

The data from each geophone during each source activation is recorded as a different channel on the recording system. The Model 170 has six channels (two simultaneous recording channels), each with a 12 bit 1024 sample record. The recorded data is displayed on a CRT display and on paper tape output as six channels with a common time scale. Data is stored on 3.5 inch floppy diskettes for further processing. Up to 8 sampling sequences can be summed to improve the signal to noise ratio of the signals.

Review of the displayed data on the CRT or paper tape allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and summing number in order to optimize the quality of the data before recording. Calibration of the Model 170 digital recorder is performed every six months, using a NITS traceable frequency source and counter, as outlined in Appendix D.

MEASUREMENT PROCEDURES

All boreholes were logged as nominal 6 in diameter uncased boreholes filled with bentonite based drilling fluid. The suspension probe was positioned with the mid-point of the receiver spacing at grade level, and mechanical and electronic depth counters were set to zero. The probe was lowered to the bottom of the borehole, then returned to the bottom of the steel conductor casing or mud level, stopping at 3.28 ft intervals to collect data.

BOREHOLE	RUN NUMBER	DEPTH RANGE	DEPTH AS DRILLED	LOST TO SLUFF	SAMPLE INTERVAL	ISOLATION TUBE
GCB-1 9/4/96	1	789.0-111.6	802	0.9	3.28	3.28
GCB-4 9/29/96	1	1023.6-787.4			3.28	3.28
	2	1036.8-1010.5 784.1-13.1	1100	51.1	3.28	3.28
GCB-5 9/29/96	1	4.9-981.0	995	1.9	3.28	3.28

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth was printed on paper tape, checked, and recorded on diskette before moving to the next depth.

Upon completion of the measurement run, the probe zero depth indication was verified prior to removal from the borehole.

DATA ANALYSIS

The recorded digital records were analyzed to locate the first minima on the vertical axis records, indicating the arrival of P-wave energy. In the case of GCB-4 and GCB-5, The vertical axis records showed no arrivals, due to equipment malfunction. This problem was identified in the field and not corrected due to time constraints. The P-wave arrivals for these boreholes were picked from redundant data included in the unfiltered horizontal axis records, and transferred to the vertical axis records. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.28 ft interval. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data.

The P-wave velocity calculated from the travel time over the 7.02 ft interval from source to receiver 1 (S-R1) was calculated and plotted for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 5.15 ft to correspond to the mid-point of the 7.02 ft S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at the near receiver and subtracting 3.90 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

The recorded digital records were studied to establish the presence of clear S_H -wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H -wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital FFT - IFFT lowpass filtering was used to remove the higher frequency P-wave signal from the S_H -wave signal. Different filter cutoffs were used to separate P- and S_H -waves at different depths, ranging from 1000 Hz in the slowest zones to 4000 Hz in the regions of highest velocity.

Generally, the first maxima was picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by ± 0.2 milliseconds,

due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by borehole inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H -wave velocity calculated from the travel time over the 7.02 ft interval from source to first receiver was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 5.15 ft to correspond to the mid-point of the 7.02 ft S-R1 interval. Travel times were obtained by picking the first break of the S_H -wave signal at the near receiver and subtracting 3.90 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

Figure 2 shows an example of R1 - R2 measurements on the filtered record for a depth of 567.6 ft in borehole GCB-1. In Figure 2, the time difference over the 3.28 ft interval of 1.30 millisecond is equivalent to a S_H -wave velocity of 2524 ft/sec. Whenever possible, time differences were determined from several phase points on the S_H -waveform records to verify the data obtained from the first arrival of the S_H -wave pulse. Figure 3 displays the same record before filtering with a 2000 Hz FFT - IFFT digital lowpass filter.

RESULTS

Suspension R1-R2 P- and S_H -wave velocities for GCB1, GCB-4, and GCB-5 are plotted in Figures 4, 6, and 8 respectively. The S_H -wave velocity data are presented at an expanded scale in Figures 5, 7, and 9. The suspension velocity data presented in the figures are presented in Tables 1 - 3. P- and S_H -wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Appendix A, Figures A1 - A6 to aid in visual comparison. It must be noted that R1-R2 data is an average velocity over a 3.28 ft segment of the soil column; S-R1 data is an average over 7.02 ft, creating a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in tabular format in Appendix A, Tables A1 - A3. Good correspondence between the shape of the P- and S_H -wave velocity curves is observed for all data sets. The velocities derived from S-R1 and R1-R2 data are in close agreement, providing verification of the higher resolution R1-R2 data.

Depth sequential S_H - and P-wave records with picks from S-R1 analysis used for quality assurance are presented in Appendices B and C. Calibration procedures and records for the measurement system are presented in Appendix D.

SUMMARY

Discussion of Results

Both P- and S_H -wave velocities were measured using the Suspension Method between depths of 4.9 and 1036.8 ft in boreholes GCB-1, GCB-4, and GCB-5 at the Savannah River Site. Data was not collected above 111.6 ft in GCB-1 due to the rapid loss of drilling fluid above this point.

The sites were in remote locations, with no apparent sources of ambient vibration nearby.

Each of the sites indicates contact with basement like material, although GCB-4 does not appear to penetrate through the weathered region into competent rock.

Quality Assurance

These velocity measurements at the Savannah River Site, boreholes GCB-1, GCB-4, and GCB-5 were performed by highly qualified professional staff members of Agbabian Associates, Inc. under the supervision and quality assurance of Dr. Robert L. Nigbor, P.E.. Industry-standard or better methods and levels of care were employed for both measurements and analyses. All work was performed under Agbabian Associates quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Where applicable, use of independent verification of data (for example, comparison of receiver-to-receiver and source-to-receiver velocities for the suspension velocity measurements)
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.28 ft interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable; the estimated precision is +/- 5%. Good field procedures and quality assurance add to the high reliability of these data.

Figure 1. Concept illustration of P-S logging system

Figure 2. Filtered (2000 Hz lowpass) 567.6 ft record from GCB-1

Figure 3. Unfiltered 567.6 ft record from GCB-1

SRS BOREHOLE GCB-1 OYO SUSPENSION LOGGING

P - AND S-WAVE VELOCITIES, DATA COLLECTED SEPTEMBER 4, 1996

Figure 4. GCB-1 Suspension R1 - R2 P- and S_H -wave velocities

SRS BOREHOLE GCB-1 OYO SUSPENSION LOGGING

S-WAVE VELOCITIES, DATA COLLECTED SEPTEMBER 4, 1996

Figure 5. GCB-1 Suspension R1 - R2 S_H -wave velocities

Depth, (feet)	Pick Times						Velocity	
	Far-Hn, (millisec)	Far-Hr, (millisec)	Far-V, (millisec)	Near-Hn, (millisec)	Near-Hr, (millisec)	Near-V, (millisec)	Vs, (ft/sec)	Vp (ft/sec)
111.6	14.44	14.50	6.44	12.08	12.12	5.82	1384	5292
114.8	15.08	15.18	6.36	11.26	11.30	5.62	852	4434
118.1	13.46	13.56	6.19	10.70	10.82	5.55	1193	5126
121.4	13.12	13.10	6.23	9.56	9.60	5.46	929	4261
124.7	11.94	12.00	6.06	8.94	9.12	5.44	1116	5249
128.0	11.54	11.72	6.07	9.22	9.32	5.48	1390	5561
131.2	11.90	11.96	6.10	9.38	9.50	5.49	1318	5423
134.5	12.40	12.48	6.00	10.18	10.28	5.52	1485	6835
137.8	12.80	12.92	6.07	10.70	10.80	5.45	1555	5335
141.1	14.36	14.50	5.98	11.92	11.96	5.44	1318	6076
144.4	16.12	16.20	6.12	13.06	13.14	5.45	1072	4897
147.6	18.04	18.16	6.14	14.06	14.18	5.48	824	4934
150.9	18.52	18.56	6.11	13.56	13.54	5.49	657	5249
154.2	16.06	16.14	6.09	10.22	10.40	5.43	567	4934
157.5	11.46	11.58	6.04	9.02	9.30	5.46	1390	5657
160.8	11.86	11.94	6.02	9.32	9.44	5.39	1302	5208
164.0	11.88	11.96	5.92	9.28	9.40	5.33	1272	5608
167.3	11.22	11.36	5.89	8.14	8.30	5.24	1069	5047
170.6	11.40	11.38	5.80	7.88	8.00	5.21	951	5561
173.9	9.62	9.68	5.63	7.76	7.86	5.22	1783	8002
177.2	10.22	10.30	5.85	8.96	9.08	5.29	2646	5859
180.1	11.42	11.48	6.03	9.02	9.08	5.38	1367	5047
183.7	12.26	12.34	6.08	9.76	9.88	5.46	1323	5249
187.0	12.90	13.60	5.96	10.02	10.74	5.39	1143	5756
190.3	12.08	12.16	6.02	8.96	8.94	5.35	1035	4934
193.6	10.92	11.00	5.91	8.70	8.78	5.40	1478	6371
196.9	10.88	11.00	6.02	8.26	8.32	5.35	1238	4897
200.1	10.42	10.54	5.90	8.46	8.54	5.31	1657	5608
203.4	10.03	10.13	5.88	8.37	8.50	5.35	1994	6190
206.7	9.92	9.98	5.90	7.68	7.67	5.36	1442	6076
210.0	9.29	9.38	5.76	7.52	7.64	5.24	1869	6249
213.3	9.21	9.32	5.72	7.59	7.69	5.17	2019	5965
216.5	9.10	9.22	5.67	7.65	7.76	5.11	2255	5859
219.8	9.29	9.44	5.64	7.59	7.70	5.11	1907	6190
223.1	9.30	10.04	5.75	7.67	8.28	5.26	1936	6696
226.4	9.18	9.32	5.81	7.62	7.42	5.30	1896	6433
229.7	9.94	9.96	5.91	8.18	8.24	5.34	1886	5807
232.9	9.70	9.78	5.89	8.10	8.20	5.36	2063	6190
236.2	9.70	9.66	5.78	7.92	7.98	5.21	1896	5807
239.5	9.64	9.64	5.74	7.86	7.98	5.19	1907	5911
242.8	9.54	9.60	5.73	7.86	7.94	5.18	1965	5965
246.1	10.24	10.94	5.87	8.48	9.26	5.33	1907	6020
249.3	9.96	10.00	5.94	8.46	8.52	5.40	2202	6076
252.6	10.14	10.98	6.03	8.64	9.58	5.46	2263	5706
255.9	10.12	11.22	6.03	8.28	9.24	5.43	1718	5468
259.2	9.92	10.10	5.80	8.12	8.28	5.26	1813	6076
262.5	9.88	9.90	5.79	8.14	8.22	5.23	1919	5859
265.8	9.60	9.64	5.75	7.76	7.90	5.20	1833	5911
269.0	9.06	9.08	5.70	7.32	7.38	5.16	1907	6020
272.3	8.82	8.92	5.67	7.28	7.38	5.15	2130	6249
275.6	8.84	8.92	5.69	7.32	7.40	5.17	2158	6249
278.9	8.73	8.80	5.66	7.30	7.39	5.15	2310	6433
282.2	8.76	8.85	5.68	7.28	7.35	5.13	2202	5965

Table 1. GCB-1 Suspension R1-R2 depth, pick times, and velocities

Depth, (feet)	Pick Times						Velocity	
	Far-Hn, (millisec)	Far-Hr, (millisec)	Far-V, (millisec)	Near-Hn, (millisec)	Near-Hr, (millisec)	Near-V, (millisec)	Vs, (ft/sec)	Vp (ft/sec)
285.4	8.77	8.87	5.68	7.13	7.22	5.12	1994	5859
288.7	8.78	8.87	5.68	7.43	7.51	5.15	2421	6132
292.0	9.08	9.17	5.72	7.53	7.62	5.17	2117	5965
295.3	9.15	9.25	5.73	7.53	7.63	5.16	2025	5756
298.6	9.10	9.22	5.70	7.56	7.67	5.13	2124	5807
301.8	9.21	9.33	5.70	7.59	7.71	5.15	2025	5965
305.1	9.22	9.32	5.72	7.59	7.68	5.17	2007	5911
308.4	9.18	9.29	5.74	7.57	7.67	5.17	2031	5807
311.7	9.23	9.33	5.75	7.54	7.63	5.21	1936	6020
315.0	9.24	9.32	5.76	7.62	7.69	5.22	2019	6020
318.2	9.33	9.39	5.77	7.66	7.72	5.22	1965	5965
321.5	9.46	9.53	5.77	7.76	7.82	5.23	1924	6020
324.8	9.56	9.63	5.69	7.77	7.84	5.13	1833	5859
328.1	9.53	9.61	5.69	7.80	7.88	5.13	1896	5911
331.4	9.68	9.77	5.69	7.97	8.05	5.15	1913	6020
334.7	9.80	9.87	5.72	7.93	7.99	5.17	1750	5911
337.9	9.75	9.82	5.71	7.94	8.01	5.15	1813	5807
341.2	9.73	9.86	5.69	7.91	8.04	5.14	1803	6020
344.5	9.79	9.88	5.71	7.93	8.03	5.16	1769	5965
347.8	9.73	9.80	5.84	7.94	8.00	5.27	1828	5807
351.1	9.57	9.69	5.72	7.70	7.82	5.15	1754	5756
354.3	9.45	9.55	5.71	7.81	7.89	5.14	1988	5807
357.6	9.56	9.62	5.73	8.03	8.12	5.19	2166	6076
360.9	9.61	9.65	5.69	8.04	8.07	5.13	2083	5807
364.2	9.84	9.92	5.76	7.98	8.06	5.19	1764	5756
367.5	9.78	9.84	5.78	7.87	7.94	5.20	1722	5706
370.7	9.76	9.82	5.87	7.95	7.99	5.29	1803	5657
374.0	9.77	9.86	5.86	7.76	7.87	5.28	1640	5608
377.3	9.47	9.59	5.83	7.73	7.84	5.26	1880	5706
380.6	9.94	10.01	5.77	8.14	8.20	5.18	1818	5608
383.9	10.10	10.10	5.78	8.30	8.20	5.20	1773	5657
387.1	10.19	10.22	5.80	8.10	8.18	5.22	1589	5706
390.4	10.00	10.07	5.80	7.99	8.06	5.18	1632	5335
393.7	9.80	9.86	5.75	7.99	8.06	5.17	1818	5706
397.0	9.77	9.84	5.74	7.89	7.94	5.16	1736	5706
400.3	9.54	9.61	5.72	7.72	7.83	5.15	1823	5756
403.5	9.60	9.66	5.73	7.81	7.89	5.16	1843	5756
406.8	9.68	9.75	5.74	7.95	8.03	5.19	1902	5911
410.1	9.67	9.75	5.74	7.97	8.05	5.17	1930	5756
413.4	9.86	9.92	5.75	8.06	8.12	5.17	1823	5706
416.7	9.86	9.93	5.75	8.03	8.11	5.18	1798	5756
420.0	9.89	9.97	5.74	8.06	8.15	5.16	1798	5657
423.2	9.90	9.99	5.73	7.98	8.08	5.16	1713	5756
426.5	9.84	9.92	5.73	8.03	8.12	5.17	1818	5807
429.8	9.76	9.84	5.76	7.94	8.02	5.19	1803	5756
433.1	10.00	10.06	5.79	8.18	8.24	5.23	1803	5807
436.4	10.06	10.12	5.81	8.16	8.24	5.23	1736	5608
439.6	10.22	10.26	5.80	8.30	8.36	5.20	1718	5468
442.9	10.46	10.52	5.80	8.66	8.72	5.22	1823	5657
446.2	11.20	11.28	5.81	9.26	9.34	5.22	1691	5561
449.5	11.18	11.22	5.84	8.84	8.96	5.25	1426	5561
452.8	11.86	11.96	5.84	8.94	9.04	5.24	1124	5514

Table 1 continued. GCB-1 Suspension R1-R2 depth, pick times, and velocities

Depth, (feet)	Pick Times						Velocity	
	Far-Hn, (millisec)	Far-Hr, (millisec)	Far-V, (millisec)	Near-Hn, (millisec)	Near-Hr, (millisec)	Near-V, (millisec)	Vs, (ft/sec)	Vp (ft/sec)
456.0	10.54	10.64	5.80	8.18	8.26	5.19	1384	5378
459.3	9.46	9.53	5.68	7.19	7.29	5.10	1455	5608
462.6	8.75	8.83	5.63	6.88	6.96	5.08	1754	5965
465.9	8.26	8.36	5.58	7.00	7.09	5.11	2594	6907
469.2	8.54	8.63	5.63	7.13	7.21	5.11	2319	6371
472.4	8.80	8.88	5.65	7.29	7.37	5.14	2173	6371
475.7	8.93	9.01	5.70	7.53	7.63	5.17	2360	6190
479.0	9.19	9.25	5.73	7.49	7.55	5.15	1930	5706
482.3	9.09	9.15	5.70	7.42	7.50	5.15	1976	5965
485.6	9.09	9.16	5.72	7.50	7.59	5.16	2076	5859
488.9	9.13	9.25	5.73	7.53	7.66	5.17	2057	5911
492.1	9.15	9.23	5.72	7.52	7.59	5.17	2007	5965
495.4	9.07	9.15	5.71	7.42	7.50	5.15	1988	5859
498.7	9.20	9.29	5.74	7.59	7.68	5.17	2038	5807
502.0	9.25	9.34	5.75	7.48	7.55	5.18	1843	5807
505.3	9.17	9.27	5.78	7.59	7.68	5.23	2070	5911
508.5	9.12	9.21	5.69	7.45	7.51	5.13	1947	5859
511.8	9.01	9.12	5.66	7.47	7.57	5.12	2124	6020
515.1	8.96	9.05	5.65	7.33	7.42	5.11	2013	6076
518.4	8.92	8.99	5.65	7.44	7.50	5.11	2209	6076
521.7	9.01	9.11	5.64	7.61	7.68	5.12	2319	6309
524.9	9.11	9.16	5.64	7.61	7.66	5.12	2187	6249
528.2	9.12	9.20	5.72	7.53	7.62	5.20	2070	6309
531.5	8.90	8.99	5.80	7.22	7.31	5.21	1953	5561
534.8	8.30	8.41	5.64	6.70	6.81	5.11	2051	6132
538.1	8.14	8.24	5.58	6.53	6.58	5.09	2007	6628
541.3	8.11	8.20	5.56	7.08	7.13	5.15	3125	8101
544.6	8.49	8.56	5.63	7.14	7.21	5.13	2430	6562
547.9	8.72	8.78	5.64	7.36	7.43	5.17	2421	7056
551.2	8.84	8.89	5.68	7.16	7.25	5.17	1976	6497
554.5	8.50	8.59	5.66	7.01	7.10	5.09	2202	5807
557.7	8.33	8.42	5.63	6.75	6.85	5.05	2083	5657
561.0	8.02	8.11	5.54	6.62	6.72	5.05	2352	6696
564.3	7.72	7.81	5.49	6.40	6.48	4.99	2476	6562
567.6	7.62	7.70	5.44	6.32	6.40	4.98	2524	7056
570.9	7.45	7.52	5.42	6.32	6.39	4.98	2903	7456
574.2	7.51	7.63	5.43	6.42	6.53	4.99	2996	7456
577.4	7.83	7.90	5.53	6.62	6.69	5.04	2711	6765
580.7	8.10	8.19	5.54	6.98	7.08	5.08	2942	7132
584.0	8.44	8.52	5.58	7.12	7.24	5.08	2524	6497
587.3	8.71	8.82	5.59	7.23	7.33	5.08	2209	6497
590.6	8.73	8.81	5.62	7.30	7.40	5.11	2310	6433
593.8	8.77	8.84	5.61	7.25	7.32	5.11	2158	6562
597.1	8.85	8.89	5.72	7.17	7.26	5.13	1982	5561
600.4	8.70	8.79	5.72	7.27	7.38	5.19	2310	6132
603.7	8.41	8.43	5.72	7.06	7.12	5.18	2467	6132
607.0	8.63	8.69	5.72	7.27	7.36	5.12	2439	5468
610.2	8.82	8.88	5.65	7.39	7.44	5.12	2286	6132
613.5	8.61	8.69	5.62	6.94	7.04	5.07	1976	6020
616.8	8.51	8.57	5.57	7.11	7.20	5.06	2369	6433
620.1	8.80	8.88	5.56	7.01	7.09	5.08	1833	6765
623.4	8.23	8.32	5.51	6.94	7.02	5.01	2533	6628
626.6	8.31	8.38	5.52	6.91	6.98	5.02	2343	6562

Table 1 continued. GCB-1 Suspension R1-R2 depth, pick times, and velocities

Depth, (feet)	Pick Times						Velocity	
	Far-Hn, (millisec)	Far-Hr, (millisec)	Far-V, (millisec)	Near-Hn, (millisec)	Near-Hr, (millisec)	Near-V, (millisec)	Vs, (ft/sec)	Vp (ft/sec)
629.9	8.22	8.30	5.56	6.98	7.06	5.09	2646	6907
633.2	8.24	8.33	5.59	6.81	6.88	5.08	2278	6433
636.5	8.15	8.24	5.58	6.84	6.93	5.08	2504	6562
639.8	8.17	8.25	5.61	6.84	6.91	5.10	2458	6497
643.0	8.10	8.14	5.60	6.76	6.81	5.08	2458	6371
646.3	7.98	8.04	5.65	6.71	6.77	5.16	2583	6628
649.6	8.09	8.15	5.54	6.73	6.78	5.04	2404	6562
652.9	8.06	8.12	5.55	6.77	6.82	5.05	2533	6628
656.2	8.08	8.14	5.49	6.85	6.89	5.00	2646	6765
659.5	8.35	8.46	5.53	6.74	6.82	5.03	2019	6562
662.7	7.95	8.01	5.54	6.75	6.80	5.04	2723	6628
666.0	8.08	8.13	5.57	6.87	6.90	5.07	2689	6628
669.3	7.98	7.90	5.67	6.73	6.62	5.18	2594	6628
672.6	8.00	8.07	5.53	6.66	6.75	5.02	2467	6433
675.9	7.21	7.30	5.37	5.90	6.01	4.90	2524	6907
679.1	6.86	6.93	5.31	5.62	5.69	4.82	2646	6765
682.4	6.59	6.59	5.14	5.67	5.66	4.77	3547	8867
685.7	6.57	6.64	5.14	5.89	5.95	4.83	4790	10583
689.0	6.85	6.90	5.33	5.79	5.82	4.90	3066	7542
692.3	6.71	6.80	5.30	5.77	5.86	4.89	3490	7906
695.9	6.66	6.74	5.31	5.76	5.83	4.90	3625	8002
698.8	7.14	7.21	5.44	6.23	6.31	5.02	3625	7812
702.1	7.82	7.89	5.53	6.98	7.06	5.15	3929	8634
705.4	8.44	8.48	5.64	7.33	7.44	5.11	3052	6249
708.7	8.65	8.70	5.55	7.12	7.19	5.08	2158	7056
711.9	8.37	8.45	5.59	6.97	7.05	5.09	2343	6562
715.2	8.32	8.40	5.60	6.98	7.06	5.16	2448	7373
718.5	8.34	8.44	5.52	7.29	7.34	5.10	3052	7812
721.8	8.61	8.72	5.63	6.94	7.00	5.09	1936	6020
725.1	8.46	8.54	5.61	6.96	7.01	5.09	2166	6249
728.4	8.51	8.65	5.64	7.19	7.25	5.14	2412	6628
731.6	8.43	8.50	5.66	6.88	6.97	5.14	2130	6309
734.9	8.00	8.02	5.57	6.28	6.41	5.06	1970	6371
738.2	7.34	7.42	5.39	5.92	5.99	4.91	2302	6835
741.5	6.64	6.70	5.24	5.54	5.56	4.77	2929	6907
744.8	6.27	6.31	5.22	5.31	5.32	4.81	3365	8002
748.0	6.18	6.18	5.03	5.28	5.29	4.65	3666	8749
751.3	5.85	5.82	4.92	5.08	5.12	4.59	4464	9942
754.6	5.63	5.70	4.86	5.05	5.10	4.58	5561	11717
757.9	5.49	5.61	4.87	4.97	5.10	4.58	6371	11313
761.2	5.56	5.56	4.81	5.05	5.10	4.56	6765	13391
764.4	5.54	5.57	4.71	5.01	5.06	4.51	6309	16404
767.7	5.31	5.38	4.60	4.87	4.95	4.40	7542	16825
771.0	5.19	5.21	4.66	4.72	4.78	4.42	7291	13961
774.3	5.04	5.10	4.58	4.66	4.72	4.39	8634	16825
777.6	5.00	5.06	4.65	4.69	4.75	4.41	10583	13670
780.8	5.06	5.12	4.56	4.73	4.79	4.36	9942	16404
782.5	5.08	5.13	4.63	4.74	4.79	4.40	9650	14265
784.1	5.14	5.18	4.66	4.79	4.83	4.44	9374	14913
785.8	5.16	5.23	4.67	4.81	4.86	4.49	9113	18748

Table 1 continued. GCB-1 Suspension R1-R2 depth, pick times, and velocities

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

SRS BOREHOLE GCB-1 OYO SUSPENSION LOGGING

P - AND S-WAVE VELOCITIES, DATA COLLECTED SEPTEMBER 4, 1996

Figure A-1. GCB-1 R1 - R2 high resolution analysis and S-R1 quality assurance analysis P- and S_H-wave data

SRS BOREHOLE GCB-1 OYO SUSPENSION LOGGING

S-WAVE VELOCITIES, DATA COLLECTED SEPTEMBER 4, 1996

Figure A-2. GCB-1 R1 - R2 high resolution analysis and S-R1 quality assurance S_H -wave data

Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)	Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)	Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)
116.7	892	4087	290.6	2328	6167	464.5	2282	6167
120.0	999	4750	293.9	2117	5958	467.8	2547	6167
123.3	1082	4782	297.1	2056	5958	471.0	2408	6060
126.5	1312	5094	300.4	2092	5958	474.3	2328	6009
129.8	1496	5169	303.7	2056	6009	477.6	2225	5858
133.1	1396	5113	307.0	2068	6009	480.9	2068	5810
136.4	1378	5094	310.3	2026	5958	484.2	2068	5810
139.7	1184	5021	313.6	2009	5958	487.4	2117	5810
143.0	1092	5246	316.8	2044	5810	490.7	2044	5810
146.2	920	5326	320.1	1997	5762	494.0	2014	5762
149.5	804	5021	323.4	1947	5762	497.3	2026	5810
152.8	725	5021	326.7	1921	5908	500.6	2080	5858
156.1	748	4951	330.0	1921	6009	503.8	2044	5810
159.4	1172	5492	333.2	1921	6060	507.1	2056	5762
162.6	1496	5094	336.5	1855	5958	510.4	2020	5647
165.9	1378	5492	339.8	1880	6009	513.7	2068	6009
169.2	1384	5408	343.1	1865	6009	517.0	2068	6277
172.5	1732	5858	346.4	1885	6009	520.2	2143	6333
175.8	1850	6060	349.6	1875	5983	523.5	2099	6221
179.0	1931	5958	352.9	1885	5958	526.8	1986	6167
182.3	1452	5492	356.2	1986	5958	530.1	2044	6113
185.3	1465	5326	359.5	1897	6034	533.4	2068	5958
188.9	1251	5094	362.8	1817	5810	536.7	2225	5958
192.2	1184	4951	366.0	1865	6060	539.9	2653	6167
195.4	1465	5326	369.3	1885	5669	543.2	2869	6167
198.7	1535	5188	372.6	1885	5669	546.5	2336	6087
202.0	1723	5169	375.9	1885	5624	549.8	2297	6167
205.3	1643	5492	379.2	1931	5535	553.1	2150	6167
208.6	1644	5429	382.5	1986	5535	556.3	2260	6009
211.8	1986	5366	385.7	1744	5762	559.6	2424	6167
215.1	2044	5715	389.0	1678	5762	562.9	2575	6277
218.4	2044	6113	392.3	1762	5669	566.2	2757	6391
221.7	1997	6009	395.6	1840	5810	569.5	3017	6892
225.0	2014	6113	398.9	1840	5810	572.7	3083	6825
228.3	2056	5715	402.1	1875	5810	576.0	3145	6792
231.5	2044	5579	405.4	1969	5958	579.3	2929	6760
234.8	1784	5669	408.7	1947	5810	582.6	2735	6450
238.1	1793	5669	412.0	1826	5810	585.9	2367	6221
241.4	1860	5762	415.3	1831	5810	589.1	2260	6167
244.7	1921	5762	418.5	1826	5762	592.4	2211	6113
247.9	1921	6060	421.8	1817	5762	595.7	2211	5958
251.2	1860	5762	425.1	1805	5834	599.0	2211	5958
254.5	1643	5094	428.4	1850	5810	602.3	2239	5908
257.8	1569	5408	431.7	1885	5810	605.5	2225	5669
261.1	1775	5492	434.9	1862	5715	608.8	2336	5762
264.3	1921	5492	438.2	1740	5579	612.1	2225	5958
267.6	1860	5762	441.5	1749	5579	615.4	2111	6060
270.9	1986	5762	444.8	1698	5669	618.7	2467	6167
274.2	2313	5858	448.1	1583	5579	622.0	2313	6221
277.5	2253	5958	451.3	1389	5579	625.2	2367	6333
280.7	2197	5958	454.6	1452	5492	628.5	2441	6632
284.0	2260	6060	457.9	1452	5492	631.8	2467	6450
287.3	2297	6167	461.2	1749	5669	635.1	2408	6167

Table A-1. GCB-1 S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)
638.4	2556	6167
641.6	2529	6167
644.9	2529	6167
648.2	2575	6221
651.5	2628	5932
654.8	2643	6450
658.0	2575	6509
661.3	2497	6760
664.6	2594	6632
667.9	2594	6632
671.2	2502	6333
674.4	2623	5908
677.7	2673	6450
681.0	3842	7641
684.3	4687	8470
687.6	4478	8573
690.9	3821	7989
694.1	3906	7725
697.4	4040	7725
701.0	4040	7725
704.0	3285	6632
707.3	2529	6167
710.5	2239	6009
713.8	2297	6277
717.1	2484	6277
720.4	2467	6391
723.7	2239	6167
726.9	2594	6420
730.2	2529	6333
733.5	2367	6167
736.8	2663	6277
740.1	3210	6632
743.3	3587	7479
746.6	4595	8573
749.9	5408	9250
753.2	5450	10115
756.5	6450	11159
759.7	6333	11248
763.0	7030	11248
766.3	6391	11717
769.6	6760	13019
772.9	8080	16541
776.2	9250	16940
779.4	10043	15622
782.7	9500	14347
786.0	9130	15977
787.6	8899	18747
789.3	8573	16349
790.9	8369	13519

Table A-1 continued. GCB-1 S - R1 quality assurance analysis
P- and S_H-wave data

Figure B-1. GCB-1 Suspension S_H -wave R1 records,
 "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

Figure B-1 continued. GCB-1 Suspension S_H -wave R1 records, "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

Figure B-1 continued. GCB-1 Suspension S_H -wave R1 records, "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

Figure B-1 continued. GCB-1 Suspension S_H -wave R1 records, "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

Figure B-1 continued. GCB-1 Suspension S_H -wave R1 records, "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

APPENDIX C

**SUSPENSION P-WAVE R1 WAVEFORM
RECORDS WITH S - R1 FIRST ARRIVAL PICKS**

Figure C-1. GCB-1 Suspension P-wave R1 records,
Vertical, unfiltered with S - R1 first arrival picks in milliseconds

Figure C-1 continued. GCB-1 Suspension P-wave R1 records, Vertical, unfiltered with S - R1 first arrival picks in milliseconds

Figure C-1 continued. GCB-1 Suspension P-wave R1 records, Vertical, unfiltered with S - R1 first arrival picks in milliseconds

Figure C-1 continued. GCB-1 Suspension P-wave R1 records, Vertical, unfiltered with S - R1 first arrival picks in milliseconds

Figure C-1 continued. GCB-1 Suspension P-wave R1 records, Vertical, unfiltered with S - R1 first arrival picks in milliseconds

SUSPENSION VELOCITY MEASUREMENTS

AT THE

SAVANNAH RIVER SITE

BOREHOLE GCB-2

July 31, 1996

SUSPENSION VELOCITY MEASUREMENTS

AT THE

SAVANNAH RIVER SITE

BOREHOLE GCB-2

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INTRODUCTION

Suspension velocity measurements were performed in borehole GCB-2 at the Savannah River Site, near Aiken, South Carolina. Suspension P- and S_H -velocity measurements were collected to a maximum depth of 668.3 ft. Data acquisition was performed on June 30, 1996. The work was conducted by Rob Steller of Agbabian Associates for the University of South Carolina and the Westinghouse Savannah River Company. Mr. Mike Waddell was the technical liaison for the University of South Carolina, with Mr. Doug Wyatt serving as project liaison for Westinghouse.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of suspension velocity measurements on June 30, 1996, between depths of 144.4 and 668.3 ft in the nominal 5 inch uncased borehole designated GCB-2, located at the Savannah River Site, near Aiken, South Carolina. The purpose of these measurements was to acquire shear wave velocities and compressional wave velocities as a function of depth which, in turn, will be used to characterize ground response to earthquake motion.

The OYO Model 170 Suspension Logging Recorder and Suspension Logging Probe were used to obtain in-situ horizontal shear and compressional wave velocity measurements at 3.28 or 1.64 ft intervals. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the velocity measurement techniques used in this study is:

Guidelines for Determining Design Basis Ground Motions, Report TR-102293,
Electric Power Research Institute, Palo Alto, California, November 1993,
Sections 7 and 8.

INSTRUMENTATION

Suspension soil velocity measurements were performed using the Model 170 Suspension Logging system, manufactured by OYO Corporation. This system directly determines the average velocity of a 3.28 ft high segment of the soil column surrounding the borehole of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The geophones that detect the wave, and the source that generates the wave, are moved as a unit in the borehole producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave generator (S_H) and compressional-wave generator (P), joined to two biaxial geophones by a flexible isolation cylinder, as shown in Figure 1. The separation of the two geophones is 3.28 ft, allowing average wave velocity in the region between the geophones to be determined by inversion of the wave travel time between the two geophones. The total length of the probe as used in this survey is approximately 22.0 ft; the center point of the geophones is approximately 14.8 ft above the bottom end of the probe. The probe receives control signals from, and sends the amplified geophone signals to, instrumentation on the surface via an armored 7 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data.

The entire probe is suspended by the cable and centered in the borehole by nylon "whiskers", therefore, source motion is not coupled directly to the borehole walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the borehole and surrounding the source. This pressure wave is converted to P and S_H -waves in the surrounding soil and rock as it impinges upon the borehole wall. These waves propagate through the soil and rock surrounding the borehole, in turn causing a pressure wave to be generated in the fluid surrounding the geophones as the soil waves pass their location.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal geophones situated parallel to the axis of motion of the source are recorded.

2. The source is fired again in the opposite direction and the horizontal geophone signals are recorded.
3. The source is fired again and the vertical geophone signals are recorded. The repeated source pattern facilitates the picking of the P and S_H -wave arrivals; reversal of the source changes the polarity of the S_H -wave pattern but not the P-wave pattern.

The data from each geophone during each source activation is recorded as a different channel on the recording system. The Model 170 has six channels (two simultaneous recording channels), each with a 12 bit 1024 sample record. The recorded data is displayed on a CRT display and on paper tape output as six channels with a common time scale. Data is stored on 3.5 inch floppy diskettes for further processing. Up to 8 sampling sequences can be summed to improve the signal to noise ratio of the signals.

Review of the displayed data on the CRT or paper tape allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and summing number in order to optimize the quality of the data before recording. Calibration of the Model 170 digital recorder is performed every six months, using a NITS traceable frequency source and counter, as outlined in Appendix D.

MEASUREMENT PROCEDURES

The borehole was logged as a 684 ft deep, nominal 5 inch diameter uncased borehole filled with bentonite based drilling mud. The suspension probe was positioned with the mid-point of the receiver spacing at grade level, and mechanical and electronic depth counters were set to zero. The probe was lowered to the bottom of the borehole, then returned to the bottom of the steel conductor casing at 144.4 ft, stopping at 3.28 or 1.64 ft intervals to collect data. During this procedure, the deepest measurement was taken with the probe depth reference point located at 668.3 ft, placing the tip of the probe within 1 ft of the bottom of the borehole at approximately 683.1 ft.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth was printed on paper tape, checked, and recorded on diskette before moving to the next depth.

Upon completion of the measurement run, the probe zero depth indication was verified prior to removal from the borehole.

DATA ANALYSIS

The recorded digital records were analyzed to locate the first minima on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.28 ft interval. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data.

The P-wave velocity calculated from the travel time over the 10.3 ft interval from source to receiver 1 (S-R1) was calculated and plotted for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 6.8 ft to correspond to the mid-point of the 10.3 ft S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at the near receiver and subtracting 3.90 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

The recorded digital records were studied to establish the presence of clear S_H -wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H -wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital FFT - IFFT lowpass filtering was used to remove the higher frequency P-wave signal from the S_H -wave signal. Different filter cutoffs were used to separate P- and S_H -waves at different depths, ranging from 1000 Hz in the slowest zones to 2500 Hz in the regions of highest velocity.

Generally, the first maxima was picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by ± 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by borehole inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the

same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H -wave velocity calculated from the travel time over the 10.3 ft interval from source to first receiver was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 6.8 ft to correspond to the mid-point of the 10.3 ft S-R1 interval. Travel times were obtained by picking the first break of the S_H -wave signal at the near receiver and subtracting 3.90 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

Figure 2 shows an example of R1 - R2 measurements on the filtered record for a depth of 183.7 ft. In Figure 2, the time difference over the 3.28 ft interval of 1.68 millisecond is equivalent to a S_H -wave velocity of 1953 ft/sec. Whenever possible, time differences were determined from several phase points on the S_H -waveform records to verify the data obtained from the first arrival of the S_H -wave pulse. Figure 3 displays the same record before filtering with a 1500 Hz FFT - IFFT digital lowpass filter.

RESULTS

Suspension R1-R2 P- and S_H -wave velocity are plotted in Figure 4. The S_H -wave velocity data are presented at an expanded scale in Figure 5. The suspension velocity data presented in Figures 4 and 5 are presented in Table 1. P- and S_H -wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figures A1 and A2 to aid in visual comparison. It must be noted that R1-R2 data is an average velocity over a 3.28 ft segment of the soil column; S-R1 data is an average over 10.3 ft, creating a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in tabular format in Table A1. Good correspondence between the shape of the P- and S_H -wave velocity curves is observed for all data sets. The velocities derived from S-R1 and R1-R2 data are in close agreement, providing verification of the higher resolution R1-R2 data.

Depth sequential S_H - and P-wave records with picks from S-R1 analysis used for quality assurance are presented in Appendices B and C. Calibration procedures and records for the measurement system are presented in Appendix D.

SUMMARY

Discussion of Results

Both P- and S_H -wave velocities were measured using the Suspension Method between depths of 144.4 ft and 668.3 ft in borehole GCB-2, at the Savannah River Site. Data was not collected above 144.4 ft due to the presence of steel conductor casing.

The site was located in a forest, with no apparent sources of ambient vibration nearby.

A significant decrease in S_H -wave velocity is observed between depths of 320 and 340 ft, indicating a soft soil layer, possibly clean sands. Another significant change in soil composition is observed between 590 and 620 ft, where the rapid increase in P- and S_H -wave velocity indicates a rock like layer. Basement rock appears to be encountered at a depth of approximately 660 ft.

Quality Assurance

These velocity measurements at the Savannah River Site, borehole GCB-2, were performed by highly qualified professional staff members of Agbabian Associates, Inc. under the supervision and quality assurance of Dr. Robert L. Nigbor, P.E.. Industry-standard or better methods and levels of care were employed for both measurements and analyses. All work was performed under Agbabian Associates quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Where applicable, use of independent verification of data (for example, comparison of receiver-to-receiver and source-to-receiver velocities for the suspension velocity measurements)

- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.28 ft interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable; the estimated precision is +/- 5%. Good field procedures and quality assurance add to the high reliability of these data.

Figure 1. Concept illustration of P-S logging system

Figure 2. Filtered (1500 Hz lowpass) 183.7 ft record

Figure 3. Unfiltered 183.7 ft record

SRS BOREHOLE GCB-2 OYO SUSPENSION LOGGING

P - AND S-WAVE VELOCITIES, DATA COLLECTED JUNE 30, 1996

Figure 4. Suspension R1 - R2 P- and S_H-wave velocities

SRS BOREHOLE GCB-2 OYO SUSPENSION LOGGING

S-WAVE VELOCITIES, DATA COLLECTED JUNE 30, 1996

Figure 5. Suspension R1 - R2 S_H -wave velocities

Depth (feet)	Pick Times						Velocity	
	Far-Hn (millisec)	Far-Hr (millisec)	Far-V (millisec)	Near-Hn (millisec)	Near-Hr (millisec)	Near-V (millisec)	Vs (ft/sec)	Vp (ft/sec)
141.1	11.70	11.78	6.33	9.80	9.86	5.75	1718	5657
144.4	11.72	11.74	6.30	9.54	9.54	5.74	1498	5859
147.6	11.24	11.34	6.27	9.46	9.56	5.70	1843	5756
150.9	11.12	11.26	6.27	9.34	9.48	5.70	1843	5756
154.2	11.16	11.26	6.25	9.24	9.34	5.69	1709	5859
157.5	10.96	11.02	6.26	9.32	9.42	5.71	2025	5965
160.8	11.06	11.16	6.25	9.40	9.50	5.71	1976	6076
164.0	11.16	11.26	6.27	9.44	9.54	5.72	1907	5965
167.3	11.16	11.24	6.27	9.40	9.48	5.71	1864	5859
170.6	11.24	11.30	6.27	9.44	9.48	5.71	1813	5859
173.9	11.06	11.14	6.24	9.28	9.36	5.68	1843	5859
177.2	10.86	10.90	6.28	9.20	9.30	5.75	2013	6190
180.5	10.60	10.68	6.23	8.90	9.00	5.67	1941	5859
183.7	10.46	10.54	6.21	8.78	8.86	5.64	1953	5756
187.0	10.36	10.52	6.16	8.76	8.72	5.65	1930	6433
190.3	11.02	11.10	6.22	9.62	9.66	5.74	2310	6835
193.6	11.08	11.16	6.24	9.60	9.68	5.73	2217	6433
196.9	11.40	11.26	6.27	9.78	9.60	5.77	2001	6562
200.1	11.54	11.60	6.30	9.68	9.74	5.69	1764	5378
203.4	11.56	11.62	6.25	9.84	9.92	5.71	1919	6076
206.7	11.84	11.90	6.28	9.94	10.00	5.72	1727	5859
210.0	11.94	12.02	6.30	10.12	10.20	5.75	1803	5965
213.3	12.06	12.12	6.33	10.22	10.28	5.77	1783	5859
216.5	12.10	12.18	6.33	10.16	10.26	5.75	1700	5657
219.8	12.06	12.14	6.31	10.04	10.12	5.73	1624	5657
223.1	12.06	12.12	6.33	10.06	10.10	5.76	1632	5756
226.4	12.04	12.12	6.36	10.12	10.20	5.80	1709	5859
229.7	11.98	12.04	6.32	10.08	10.18	5.77	1745	5965
232.9	12.10	12.18	6.34	10.28	10.38	5.78	1813	5859
236.2	12.28	12.32	6.47	10.26	10.32	5.91	1632	5859
239.5	12.48	12.48	6.37	10.42	10.44	5.79	1600	5657
242.8	12.32	12.36	6.40	10.44	10.50	5.85	1754	5965
246.1	12.04	12.08	6.40	10.08	10.14	5.83	1682	5756
249.3	11.78	11.84	6.41	9.88	9.96	5.82	1736	5561
252.6	11.38	11.38	6.32	9.20	9.30	5.73	1540	5561
255.9	10.82	10.94	6.36	8.96	9.06	5.78	1754	5657
259.2	11.86	11.96	6.41	10.02	10.12	5.84	1783	5756
262.5	12.36	12.48	6.40	10.90	11.02	5.85	2247	5965
265.8	11.78	11.84	6.41	10.30	10.34	5.87	2202	6076
269.0	12.02	12.08	6.38	10.56	10.56	5.78	2202	5468
272.3	12.60	12.68	6.36	10.94	10.98	5.77	1953	5561
275.6	12.52	12.66	6.35	10.34	10.46	5.78	1498	5756
278.9	12.16	12.18	6.35	10.30	10.42	5.81	1813	6076
282.2	12.44	12.48	6.36	10.62	10.64	5.78	1793	5657
285.4	12.26	12.32	6.38	10.58	10.68	5.80	1976	5657
288.7	12.34	12.38	6.32	10.24	10.26	5.75	1555	5756
292.0	12.00	12.06	6.31	10.36	10.44	5.75	2013	5859
295.3	12.26	12.28	6.32	9.84	9.90	5.74	1367	5657
298.6	11.72	11.80	6.31	10.00	10.10	5.76	1919	5965
302.2	11.54	11.60	6.31	9.66	9.72	5.74	1745	5756
305.1	11.32	11.38	6.30	9.56	9.68	5.72	1896	5657
308.4	11.36	11.42	6.28	9.52	9.62	5.71	1803	5756
311.7	11.82	11.92	6.27	10.12	10.18	5.71	1907	5859

Table 1. Suspension R1-R2 depth, pick times, and velocities

Depth (feet)	Pick Times						Velocity	
	Far-Hn (millisec)	Far-Hr (millisec)	Far-V (millisec)	Near-Hn (millisec)	Near-Hr (millisec)	Near-V (millisec)	Vs (ft/sec)	Vp (ft/sec)
315.0	12.92	12.98	6.32	11.46	11.52	5.77	2247	5965
318.2	15.54	15.72	6.35	13.44	13.48	5.80	1512	5965
321.5	15.94	15.98	6.49	14.60	14.58	5.89	2395	5468
324.8	16.64	16.72	6.48	14.18	14.26	5.88	1334	5468
328.1	16.02	16.10	6.46	13.62	13.64	5.88	1350	5657
331.4	15.28	15.44	6.47	12.44	12.46	5.85	1127	5292
334.7	14.28	14.32	6.37	11.52	11.66	5.75	1211	5292
337.9	13.66	13.72	6.32	10.42	10.40	5.73	1000	5561
341.2	11.96	12.00	6.28	10.18	10.22	5.74	1843	6076
344.5	11.94	11.98	6.29	10.18	10.24	5.77	1875	6309
347.8	11.70	11.76	6.29	9.98	10.12	5.73	1953	5859
351.1	11.86	11.98	6.28	9.60	9.76	5.72	1465	5859
354.3	11.66	11.72	6.29	9.88	9.96	5.72	1854	5756
357.6	11.44	11.50	6.28	9.68	9.80	5.75	1896	6190
360.9	11.42	11.50	6.30	9.90	9.96	5.75	2144	5965
364.2	11.86	11.92	6.31	10.26	10.34	5.76	2063	5965
367.5	11.94	12.02	6.32	9.74	9.84	5.73	1498	5561
370.7	11.58	11.66	6.29	9.82	9.92	5.72	1875	5756
374.0	11.72	11.80	6.44	9.86	9.92	5.86	1754	5657
377.0	11.68	11.74	6.37	9.82	9.90	5.81	1773	5859
380.6	11.40	11.48	6.36	9.72	9.80	5.80	1953	5859
383.9	11.34	11.42	6.29	9.52	9.58	5.73	1793	5859
387.1	11.26	11.30	6.27	9.36	9.42	5.71	1736	5859
390.4	11.18	11.20	6.31	9.34	9.40	5.76	1803	5965
393.7	10.86	10.88	6.29	9.32	9.36	5.77	2144	6309
397.0	10.70	10.78	6.24	9.12	9.20	5.74	2076	6562
400.3	10.46	10.54	6.22	8.74	8.80	5.66	1896	5859
403.5	10.20	10.24	6.17	8.28	8.36	5.63	1727	6076
406.8	9.68	9.76	6.15	8.16	8.24	5.61	2158	6076
410.1	9.66	9.76	6.10	8.38	8.46	5.61	2543	6696
413.4	9.98	10.08	6.17	8.54	8.64	5.62	2278	5965
416.7	10.06	10.18	6.19	8.70	8.80	5.68	2395	6433
420.0	10.32	10.40	6.22	9.04	9.12	5.71	2563	6433
423.2	10.58	10.68	6.27	9.02	9.12	5.71	2103	5859
426.5	10.68	10.76	6.27	8.86	8.94	5.70	1803	5756
429.8	10.64	10.72	6.26	9.08	9.16	5.70	2103	5859
433.1	10.72	10.82	6.26	9.16	9.26	5.68	2103	5657
436.4	10.72	10.82	6.21	9.10	9.22	5.68	2038	6190
439.6	10.80	10.88	6.22	9.22	9.34	5.69	2103	6190
442.9	10.76	10.88	6.23	8.96	9.10	5.67	1833	5859
446.2	10.64	10.72	6.23	9.12	9.20	5.70	2158	6190
449.5	10.48	10.56	6.21	8.86	8.94	5.66	2025	5965
452.8	10.48	10.54	6.18	8.90	8.94	5.65	2063	6190
456.0	10.60	10.64	6.22	8.96	9.00	5.66	2001	5859
459.3	10.48	10.54	6.18	8.96	9.02	5.66	2158	6309
462.6	10.64	10.72	6.36	9.34	9.40	5.84	2504	6309
465.9	10.72	10.76	6.37	9.02	9.08	5.79	1941	5657
469.2	10.44	10.48	6.31	9.00	9.10	5.75	2327	5859
472.4	10.28	10.34	6.29	8.98	9.04	5.73	2524	5859
475.7	10.24	10.34	6.29	8.54	8.64	5.75	1930	6076
479.0	10.16	10.22	6.28	8.70	8.78	5.74	2263	6076
482.3	9.82	9.88	6.10	8.32	8.38	5.58	2187	6309
485.6	9.52	9.60	6.16	8.00	8.10	5.69	2173	6981

Table 1 continued. Suspension R1-R2 depth, pick times, and velocities

Depth (feet)	Pick Times						Velocity	
	Far-Hn (millisec)	Far-Hr (millisec)	Far-V (millisec)	Near-Hn (millisec)	Near-Hr (millisec)	Near-V (millisec)	Vs (ft/sec)	Vp (ft/sec)
488.9	9.16	9.42	6.07	7.72	7.98	5.53	2278	6076
492.1	8.94	9.02	5.98	7.50	7.58	5.50	2278	6835
495.4	8.88	8.96	6.01	7.82	7.88	5.56	3066	7291
498.7	8.94	9.04	5.95	7.76	7.86	5.47	2780	6835
502.0	8.92	9.00	5.99	7.68	7.78	5.53	2667	7132
505.3	9.06	9.18	5.95	7.90	8.00	5.49	2804	7132
508.5	9.26	9.34	6.05	7.90	7.98	5.55	2412	6562
511.8	9.46	9.54	6.07	8.40	8.44	5.60	3038	6981
515.1	10.00	10.04	6.13	8.70	8.76	5.62	2543	6433
518.4	10.98	11.06	6.21	9.64	9.70	5.70	2430	6433
521.7	11.12	11.22	6.26	9.74	9.84	5.74	2377	6309
524.9	12.52	12.40	6.34	11.30	11.16	5.80	2667	6076
528.2	12.76	12.90	6.51	10.72	10.88	5.86	1616	5047
531.5	12.06	12.10	6.49	10.14	10.18	5.87	1709	5292
534.8	12.28	12.24	6.38	10.46	10.54	5.76	1864	5292
538.1	11.76	11.82	6.26	9.72	9.80	5.65	1616	5378
541.3	11.16	11.20	6.17	8.26	8.30	5.58	1131	5561
544.6	9.76	9.86	6.32	8.36	8.38	5.81	2278	6433
547.9	10.02	10.10	6.21	8.76	8.78	5.69	2543	6309
551.2	11.54	11.62	6.27	10.20	10.26	5.76	2430	6433
554.5	12.68	12.76	6.27	11.30	11.40	5.74	2395	6190
557.7	11.10	11.12	6.25	10.04	10.08	5.75	3125	6562
561.0	11.12	11.12	6.27	9.56	9.56	5.70	2103	5756
564.3	10.62	12.54	6.29	9.48	9.56	5.70	1593	5561
567.6	10.06	10.12	6.22	8.26	8.32	5.66	1823	5859
570.9	9.44	9.56	6.29	8.06	8.16	5.77	2360	6249
574.2	9.27	9.38	6.25	8.00	8.09	5.75	2563	6628
577.4	9.39	9.50	6.18	8.08	8.16	5.68	2476	6562
580.7	9.28	9.35	6.14	7.98	8.05	5.65	2524	6765
584.0	9.07	9.15	6.14	7.79	7.87	5.65	2563	6696
587.3	8.46	8.54	6.01	7.12	7.20	5.54	2448	6907
590.6	8.69	8.82	5.71	7.22	7.33	5.24	2217	6981
592.2	8.26	8.50	5.63	6.93	7.12	5.18	2421	7291
593.8	8.06	8.24	5.58	6.75	6.92	5.14	2495	7456
595.5	7.01	7.12	5.54	6.10	6.16	5.13	3509	8002
597.1	6.88	6.92	5.64	6.15	6.19	5.24	4494	8101
598.8	6.89	8.17	5.60	6.20	7.30	5.06	4206	6076
600.4	6.93	7.01	5.53	6.29	6.37	5.20	5126	10095
602.0	6.91	6.99	5.44	6.20	6.28	5.01	4621	7630
603.7	6.93	6.99	5.45	6.17	6.24	5.09	4345	9113
607.0	7.03	7.03	5.56	6.38	6.40	5.22	5126	9650
610.2	7.16	7.23	5.63	6.21	6.29	5.19	3472	7542
613.5	7.44	7.46	5.69	6.70	6.80	5.26	4687	7630
616.8	7.80	7.90	5.74	7.04	7.14	5.33	4317	8002
620.1	8.00	8.10	5.94	7.24	7.36	5.55	4374	8412
623.4	8.40	8.46	5.87	7.34	7.40	5.41	3095	7132
626.6	8.36	8.44	5.88	7.22	7.28	5.41	2853	6981
628.3	8.26	8.34	5.84	7.24	7.32	5.44	3217	8202
629.9	8.34	8.42	5.84	7.42	7.50	5.44	3566	8202
631.6	8.46	8.54	5.88	7.50	7.58	5.44	3418	7456
633.2	8.80	8.84	5.91	7.72	7.80	5.47	3095	7456
634.8	8.86	8.94	5.94	7.76	7.84	5.49	2983	7291
636.5	8.98	9.06	5.97	7.90	7.96	5.54	3010	7630

Table 1 continued. Suspension R1-R2 depth, pick times, and velocities

Depth (feet)	Pick Times						Velocity	
	Far-Hn (millisec)	Far-Hr (millisec)	Far-V (millisec)	Near-Hn (millisec)	Near-Hr (millisec)	Near-V (millisec)	Vs (ft/sec)	Vp (ft/sec)
638.1	9.16	9.22	5.99	8.16	8.26	5.58	3348	8002
639.8	9.42	9.44	6.06	8.44	8.50	5.64	3418	7812
641.4	9.78	9.80	6.13	8.74	8.80	5.70	3217	7630
643.0	9.94	10.02	6.17	8.64	8.66	5.68	2467	6696
644.7	9.72	9.82	6.16	8.16	8.20	5.63	2063	6190
646.3	9.22	9.34	5.98	7.80	7.84	5.47	2247	6433
648.0	8.78	8.84	5.85	7.42	7.40	5.36	2343	6696
649.6	8.48	8.52	5.78	7.06	7.10	5.27	2310	6433
651.3	7.98	8.10	5.80	6.56	6.64	5.28	2278	6309
652.9	7.65	7.67	5.71	6.00	6.04	5.21	2001	6562
654.5	7.13	7.10	5.51	5.98	6.01	5.06	2929	7291
656.2	6.49	6.60	5.57	5.87	5.94	5.22	5126	9510
657.8	6.45	6.48	5.28	5.76	5.81	4.93	4825	9374
659.5	6.44	6.47	5.27	5.77	5.83	4.97	5009	10936
661.1	6.35	6.42	5.27	5.76	5.82	5.01	5514	12619
662.7	6.41	6.40	5.18	5.62	5.69	4.81	4374	8867
664.4	6.36	6.41	5.43	5.72	5.84	5.00	5423	7630
666.0	6.57	6.64	5.33	5.77	5.85	4.95	4127	8634
667.3	6.49	6.32	5.42	5.51	5.54	4.90	3728	6249
668.3	6.05	6.10	5.24	5.47	5.52	4.97	5657	12151

Table 1 continued. Suspension R1-R2 depth, pick times, and velocities

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT
QUALITY ASSURANCE SUSPENSION SOURCE
TO RECEIVER ANALYSIS RESULTS

SRS BOREHOLE GCB-2 OYO SUSPENSION LOGGING

P - AND S-WAVE VELOCITIES, DATA COLLECTED JUNE 30, 1996

Figure A-1. R1 - R2 high resolution analysis and S-R1 quality assurance analysis P- and S_H -wave data

SRS BOREHOLE GCB-2 OYO SUSPENSION LOGGING

S-WAVE VELOCITIES, DATA COLLECTED JUNE 30, 1996

Figure A-2. R1 - R2 high resolution analysis and S-R1 quality assurance S_H -wave data

Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)	Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)	Depth (feet)	S-R1 Vs (ft/sec)	S-R1 Vp (ft/sec)
147.87	1813	5722	344.72	1678	5787	541.37	1639	5819
151.15	1929	5787	348.00	1770	5787	544.85	1873	6131
154.43	1943	5886	351.28	1776	5659	548.13	2512	6280
157.71	1988	5852	354.56	1826	5787	551.41	2476	6319
160.99	2012	5920	357.84	1922	5852	554.69	2210	6319
164.27	2004	5886	361.12	1846	5852	557.97	1711	5852
167.55	1996	5852	364.40	1907	5787	561.25	1443	5787
170.83	1996	5852	367.68	1833	5722	564.53	1758	5722
174.11	2020	5852	370.96	1758	5659	567.81	1951	5920
177.39	2020	5852	374.24	1873	5722	571.09	2352	5988
180.67	2060	5852	377.52	1826	5722	574.38	2458	5988
183.96	2119	6023	380.81	1810	5450	577.66	2608	5920
187.24	2229	6319	383.76	1846	5538	580.94	2682	6417
190.52	2249	6319	387.37	1853	5598	584.22	2608	6438
193.80	2289	6319	390.65	1929	5852	587.50	2668	6498
197.08	1943	6095	393.93	1996	5920	590.78	2830	6754
200.36	1929	5920	397.21	2020	5722	594.06	3515	7254
203.64	1907	5852	400.49	2052	5722	597.34	3323	8240
206.92	1922	6059	403.77	2119	5787	598.98	3679	8477
210.20	1833	5920	407.05	2341	6059	600.62	3931	8512
213.48	1794	5852	410.33	2537	6205	602.26	4952	8729
216.76	1770	5787	413.61	2537	6205	603.90	4813	8692
220.04	1752	5722	416.89	2395	6205	605.54	4703	8879
223.33	1776	5787	420.18	2341	6131	607.18	4619	8273
226.61	1813	5787	423.46	2249	5920	608.82	4813	8655
229.89	1813	5691	426.74	2128	5852	610.46	4858	8655
233.17	1776	5659	430.02	2146	5852	613.75	4402	8142
236.45	1788	5598	433.30	2210	5852	617.03	4703	8273
239.73	1728	5598	436.58	2137	5920	620.31	3902	7574
243.01	1752	5598	439.86	2077	5920	623.59	3433	7254
246.29	1717	5598	443.14	2128	5988	626.87	3259	7153
249.57	1705	5479	446.42	2111	5920	630.15	3179	7153
252.85	1826	5479	449.70	2173	5988	633.43	3323	7055
256.13	1922	5598	452.98	2102	5920	635.07	3280	6959
259.41	2060	5852	456.27	2206	5954	636.71	3084	6959
262.70	2229	5722	459.55	2191	5988	638.35	3012	6959
265.98	1981	5659	462.83	2146	5988	639.99	2845	6776
269.26	1776	5479	466.11	2146	5852	641.63	2814	6688
272.54	1728	5479	469.39	1988	5691	643.27	2711	6603
275.82	1672	5659	472.67	2146	5852	644.91	2537	6438
279.10	1570	5787	475.95	2164	6059	646.55	2373	6205
282.38	1717	5659	479.23	2191	6168	648.19	2229	6131
285.66	1728	5598	482.51	2269	6205	649.83	2320	6059
288.94	1672	5659	485.79	2229	6205	651.48	2537	6358
292.22	1661	5598	489.07	2488	6438	653.12	2861	6959
295.50	1764	5787	492.35	2682	6358	654.76	3239	7464
298.78	1740	5787	495.64	2845	6603	656.40	3679	7923
302.07	1853	5787	498.92	3084	6688	658.04	4221	8443
305.35	1833	5754	502.20	2845	6603	659.68	5337	8879
308.96	1922	5787	505.48	2877	6776	661.32	5421	9364
311.91	1981	5920	508.76	2910	6776	662.96	5722	9626
315.19	1977	5886	512.04	2739	6776	664.60	6095	10000
318.47	1752	5852	515.32	2668	6603	666.24	6023	9626
321.75	1431	5722	518.60	2384	6358	667.88	6168	9904
325.03	1132	5598	521.88	2239	6131	669.52	6519	10098
328.31	1002	5365	525.16	1907	5920	671.16	7103	10098
331.59	1040	5365	528.44	1859	5787	672.80	7203	10098
334.87	1108	5365	531.72	1478	5628	674.11	7007	10352
338.15	1262	5479	535.01	1407	5421	675.10	7007	10198
341.44	1451	5722	538.29	1488	5659			

Table A-1. S - R1 quality assurance analysis P- and S_H-wave data

APPENDIX B

SUSPENSION S_H -WAVE R1 WAVEFORM RECORDS WITH S - R1 FIRST ARRIVAL PICKS

Figure B-1. Suspension S_H -wave R1 records,
 "Normal" direction, filtered with S - R1 first arrival picks in milliseconds

Figure B-1 continued. Suspension S_H -wave R1 records

Near-Hn <Filter>

Figure B-1 continued. Suspension S_H -wave R1 records

Figure B-1 continued. Suspension S_H -wave R1 records

APPENDIX C

**SUSPENSION P-WAVE R1 WAVEFORM
RECORDS WITH S - R1 FIRST ARRIVAL PICKS**

Near-U <Raw>

Figure C-1. Suspension S_H -wave R1 records,
Vertical, unfiltered with S - R1 first arrival picks in milliseconds

Near-V <Raw>

Figure C-1 continued. Suspension S_H -wave R1 records

Near-U <Raw>

Depth

446.2ft	5.640
449.5ft	5.630
452.8ft	5.620
456.0ft	5.620
459.3ft	5.660
462.6ft	5.710
465.9ft	5.660
469.2ft	5.600
472.4ft	5.570
475.7ft	5.560
479.0ft	5.560
482.3ft	5.500
485.6ft	5.520
488.9ft	5.460
492.1ft	5.440
495.4ft	5.460
498.7ft	5.420
502.0ft	5.420
505.3ft	5.420
508.5ft	5.460
511.8ft	5.520
515.1ft	5.580
518.4ft	5.640
521.7ft	5.680
524.9ft	5.730
528.2ft	5.800
531.5ft	5.720
534.8ft	5.670
538.1ft	5.580
541.3ft	5.540
544.6ft	5.530
547.9ft	5.530
551.2ft	5.660
554.5ft	5.680
557.7ft	5.700
561.0ft	5.640
564.3ft	5.620
567.6ft	5.620
570.9ft	5.640
574.2ft	5.505
577.4ft	5.500
580.7ft	5.485
584.0ft	5.425
587.3ft	5.320
590.5ft	5.150
592.2ft	5.115

6.00

8.00

10.00

12.00

Figure C-1 continued. Suspension S_H -wave R1 records

Near-V <Raw>

Depth

593.8ft	5.110
595.5ft	5.080
597.1ft	5.085
598.8ft	5.060
600.4ft	5.145
602.0ft	5.090
603.7ft	5.090
607.0ft	5.165
610.2ft	5.145
613.5ft	5.260
616.8ft	5.320
620.1ft	5.340
623.4ft	5.340
626.6ft	5.360
628.3ft	5.380
629.9ft	5.380
631.6ft	5.380
633.2ft	5.420
634.8ft	5.440
636.5ft	5.460
638.1ft	5.500
639.8ft	5.560
641.4ft	5.580
643.0ft	5.600
644.7ft	5.520
646.3ft	5.380
648.0ft	5.280
649.6ft	5.200
651.3ft	5.120
652.9ft	5.060
654.5ft	5.000
656.2ft	4.970
657.8ft	4.930
659.5ft	4.970
661.1ft	4.940
662.7ft	4.920
664.4ft	4.920
666.0ft	4.920
667.3ft	4.895
668.3ft	4.910

Figure C-1 continued. Suspension S_H -wave R1 records

APPENDIX D

OYO 170 VELOCITY LOGGING SYSTEM

NIST TRACEABLE

CALIBRATION PROCEDURE

TABLE D1

**AGBABIAN ASSOCIATES' VELOCITY LOGGING
EQUIPMENT DESCRIPTION AND
CALIBRATION PROCEDURES**

EQUIPMENT	FUNCTION	CALIBRATION REQUIREMENTS	MAINTENANCE REQUIREMENTS
OYO Model 170 Suspension Logging Data Logger	Records data from probe and sends control signals to probe	Every six months, calibrate sample clock using an NTIS-traceable external signal counter and signal generator per attached procedure. (see Attachment D2)	Diagnose and repair by manufacturer's authorized representative if sample clock is out of specification or instrument fails.
OYO Model 170 Suspension Logging Probe	Suspended in borehole to provide both seismic source and sense wave arrivals at two locations 1 meter apart	No sensor calibration is necessary, as amplitude is not important to the velocity measurement.	Repair as needed by manufacturer-trained personnel.
Winch System (several interchangeable models available)	The winch and cable suspend the probe in the borehole and connect it to the data logger	No calibration required	Repair as needed. Lubricate moving parts frequently, and keep cable clean.

ATTACHMENT D2

CALIBRATION PROCEDURE FOR AGBABIAN ASSOCIATES' VELOCITY LOGGING SYSTEM

1.0 OYO Model 170 Data Logger Unit

1.1 Purpose

The purpose of this calibration procedure is to verify that the sample clock of the OYO Model 170 is accurate to within 1%.

1.2 Calibration Frequency

The calibration described in this procedure shall be performed every six months minimum.

1.3 Test Equipment

- Function Generator, Krohn Hite 5400B or equivalent
- Frequency Counter, HP 5315A or equivalent, current NIST traceable calibration
- Test cable, function generator to OYO 170 Data Logger input channels

1.4 Procedure

- Connect function generator to OYO Model 170 data logger using test cable
- Set up function generator to produce a 100.0 Hz, 0.250 volt peak square wave
- Record a data record with 100 microsecond sample period
- Measure the square wave frequency in the digital data using the data logger's screen display or utility software

1.5 Calibration Criteria

The measured square wave frequency in the digital data must fall between 99.0 and 101.0 Hz to be deemed acceptable. If outside this range, the data logger must be repaired and retested.

AGBABIAN ASSOCIATES
engineers and consultants

1111 South Arroyo Parkway, Suite 470, Pasadena, CA 91105 • (818) 441-1060 • FAX: (818) 441-0757

OYO 170 SUSPENSION PS LOG RECORDER CALIBRATION SHEET rev. 7/11/95

SYSTEM MFG.: OYO CORPORATION MODEL NO.: 3331
SERIAL NO.: 12004 CALIBRATION DATE: 4/7/96
BY: R. Stenzel RF SR CAL DUE DATE: 10/2/96

COUNTER MFG.: HEWLETT PACKARD MODEL NO.: 5315A
SERIAL NO.: 2536A 16357 CALIBRATION DATE: 12/5/95
BY: Simco CAL DUE DATE: 6/5/96

SIG GEN MFG.: HEWLETT PACKARD MODEL NO.: 3310A
SERIAL NO.: 1151A 12168 CALIBRATION DATE: 12/5/95
BY: Simco CAL DUE DATE: 12/5/96

SYSTEM SETTINGS:

GAIN: ALL CHANNELS TO 10
FILTER: ALL LOW TO 5HZ, ALL HI TO 25KHZ
RANGE: 100MICROSEC
DELAY: 4MILLISEC (STD)
STACK: 1 (STD)
PULSE: 1.6MILLISEC (STD)
DISPLAY: VARIABLE (STD)
PRINT: SHORT/VERT SIZE=1 (STD)
SYSTEM: MODE=SEMI AUTO (STD)
SYSTEM: DATA FORMAT=HIGH-LOW (STD)
SYSTEM: SHEAVE=500 PULSE/M (STD)
SYSTEM: DATE=CORRECT DATE & TIME

✓
✓
✓
✓
✓
✓
✓
✓
✓
✓
✓
✓

SET FREQUENCY TO 100.0 HZ, SINE WAVE AMPLITUDE TO 0.250 VOLTS PEAK (0.1768 VOLTS RMS). SET SQUARE WAVE AMPLITUDE TO 0.250 VOLTS PEAK. RECORD BOTH ON DISKETTE AND PAPER TAPE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.: ✓

WAVEFORM	FILE NO	FREQ.	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVG FREQ.
SINE		100.01	90.00	90.01	90.00	100.00
SINE		100.00	90.00	90.00	90.00	100.00
SQUARE		100.00	90.00	90.00	90.00	100.00
SQUARE		100.00	90.00	90.00	90.00	100.00

AGBABIAN ASSOCIATES
engineers and consultants

1111 South Arroyo Parkway, Suite 470, Pasadena, CA 91105 • (818) 441-1060 • FAX: (818) 441-0757

OYO 170 SUSPENSION PS LOG RECORDER CALIBRATION SHEET rev.7/11/95

SYSTEM MFG.: OYO CORPORATION MODEL NO.: 3331
SERIAL NO.: 15014 CALIBRATION DATE: 4/7/96
BY: R. STEVEN Alf Sh CAL DUE DATE: 10/1/96

COUNTER MFG.: HEWLETT-PACKARD MODEL NO.: 5315A
SERIAL NO.: 2536A 16357 CALIBRATION DATE: 12/5/95
BY: _____ CAL DUE DATE: 6/5/96

SIG GEN MFG.: HEWLETT-PACKARD MODEL NO.: 3310A
SERIAL NO.: 1151A 12168 CALIBRATION DATE: 12/5/95
BY: _____ CAL DUE DATE: 12/5/96

SYSTEM SETTINGS:

GAIN: ALL CHANNELS TO 10
FILTER: ALL LOW TO 5HZ, ALL HI TO 25KHZ
RANGE: 100MICROSEC
DELAY: 4MILLISEC (STD)
STACK: 1 (STD)
PULSE: 1.6MILLISEC (STD)
DISPLAY: VARIABLE (STD)
PRINT: SHORT/VERT SIZE=1 (STD)
SYSTEM: MODE=SEMI AUTO (STD)
SYSTEM: DATA FORMAT=HIGH-LOW (STD)
SYSTEM: SHEAVE=500 PULSE/M (STD)
SYSTEM: DATE=CORRECT DATE & TIME

✓
✓
✓
✓
✓
✓
✓
✓
✓
✓
✓
✓

SET FREQUENCY TO 100.0 HZ, SINE WAVE AMPLITUDE TO 0.250 VOLTS PEAK (0.1768 VOLTS RMS). SET SQUARE WAVE AMPLITUDE TO 0.250 VOLTS PEAK. RECORD BOTH ON DISKETTE AND PAPER TAPE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.: ✓

WAVEFORM	FILE NO	FREQ.	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVG FREQ.
SINE	101	100.00	90.00	90.00	90.00	100.00
SINE	102	100.00	90.00	90.00	90.00	100.00
SQUARE	201	100.00	90.00	90.00	90.00	100.00
SQUARE	202	100.00	90.00	90.00	90.00	100.00

REPORT NUMBER: 281519

SIMCO ELECTRONICS
10200 PIONEER BOULEVARD, SANTA FE SPRINGS, CA 90670

CERTIFICATE OF CALIBRATION

for

KINEMATRICS

HEWLETT-PACKARD, 5315A, FREQUENCY COUNTER
I.D. NO.: 5149-158 S/N: 2536A16337
DEPT. NO.: TEST ASSET NO.: 0169 PO: 28508

CALIBRATION DATE: 12/05/95
NEXT CAL: 06/05/96

REASON FOR SERVICE: PERIODIC CHECK
CONDITION ON ARRIVAL: MEETS MANUFACTURER'S SPEC'S.
DISPOSITION: CLEAN/CALIBRATE TO MFR'S SPEC

TEMPERATURE: 72 Degrees Fahrenheit

RELATIVE HUMIDITY: 43 %

STANDARDS USED:

TYPE/MODEL	CONT-ITEM	DUE DATE/INT	ACCY.	NIST NO.
UNIVERSAL COUNTER/5335A	1004*713	08/01/96 A	<5X10E-10	FREQ WWVB
FUNCTION GENERATOR/FG502	1005*530	10/10/96 A	FREQ+- .3PPM	WWVB
FUNCTION GENERATOR/FG502	1005*530	10/10/96 A	DIST<0.5%	WWVB
SINEWAVE GENERATOR/SG503	1005*97	05/16/96 S	+/-3% FLAT	253135

I, JESUS PARDO, TECHNICIAN
CERTIFY THAT THE ABOVE WORK WAS COMPLETED IN ACCORDANCE WITH INDUSTRY
ACCEPTED METHODS. SIMCO'S CALIBRATION SYSTEM COMPLIES WITH MIL-STD-45662A
AND CALIBRATION WAS PERFORMED USING STANDARDS THAT ARE TRACEABLE TO THE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY.

I, PAUL KEEP, SUPERVISOR
ACCEPT THIS INSTRUMENT AS CONFORMING TO CUSTOMER REQUIREMENTS.
DATED: 12/05/95

REPORT NUMBER: 281520

SIMCO ELECTRONICS
10200 PIONEER BOULEVARD, SANTA FE SPRINGS, CA 90670

CERTIFICATE OF CALIBRATION

for

KINEMATRICS

HEWLETT-PACKARD, 3310A, FUNCTION GENERATOR
I.D. NO.: 5149-54 S/N: 1151A12168
DEPT. NO.: TEST ASSET NO.: 0563 PO: 28508

CALIBRATION DATE: 12/05/95
NEXT CAL: 12/05/96

REASON FOR SERVICE: PERIODIC CHECK
CONDITION ON ARRIVAL: MEETS MANUFACTURER'S SPEC'S.
DISPOSITION: CLEAN/CALIBRATE TO MFR'S SPEC

DETAIL OF WORK PERFORMED:
POWER LIGHT DOES NOT WORK.

TEMPERATURE: 72 Degrees Fahrenheit

RELATIVE HUMIDITY: 43 %

STANDARDS USED:

TYPE/MODEL	CONT-ITEM	DUE DATE/INT	ACCY.	NIST NO.
SCOPE/SC504	1004*194	01/18/96 S	+/-2% AMP	253135
SCOPE/SC504	1004*194	01/18/96 S	+/-2% TIME	WWVB
SCOPE/SC504	1004*194	01/18/96 S	RT=<4.4 nS	250671
UNIVERSAL COUNTER/5335A	1004*713	08/01/96 A	<5X10E-10	FREQ WWVB
DISTORTION ANALYZER/AA501	1004*187	05/07/96 S	+/-1dB DIST	0183/3393
DISTORTION ANALYZER/AA501	1004*187	05/07/96 S	+/-2% FREQ	WWVB

I, JESUS PARDO, TECHNICIAN
CERTIFY THAT THE ABOVE WORK WAS COMPLETED IN ACCORDANCE WITH INDUSTRY
ACCEPTED METHODS. SIMCO'S CALIBRATION SYSTEM COMPLIES WITH MIL-STD-45662A
AND CALIBRATION WAS PERFORMED USING STANDARDS THAT ARE TRACEABLE TO THE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY.

I, PAUL KEEP, SUPERVISOR
ACCEPT THIS INSTRUMENT AS CONFORMING TO CUSTOMER REQUIREMENTS.
DATED: 12/05/95

WSRC-RP-97-0185

Revision 0

June, 1997

Appendix C
Palynology Correspondence for GCB-1 and 2

WSRC-RP-97-0185

Revision 0

June, 1997

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September 10, 1996

Dear Doug,

I laid out the GCB2 core yesterday and selected 16 samples for paly processing. I'm not too confident that we'll recover any fossils from these samples (pretty well oxidized), but the clay between 409 and 416-6 is a medium gray, and might, just might, yield a useable microflora. Enclosed is a copy of the transmittal letter that accompanied the samples to the processing lab, and a spreadsheet of the boxes, associated depths, and samples taken from GCB2; these are for your files.

The GCB1A sample @ 440' should be here any day, and I'm pretty excited about looking at it. I spoke with the technician who's handling the processing, and he said it looked "loaded" with fossils. When it reaches my desk and I've had a chance to examine the slides, I'll call you with my results and follow that up with a written report (again for the files).

Thanks for all you help, Doug. I'm looking forward to getting this summer's cores analyzed and to sitting down and arguing over the results.

Regards,

A handwritten signature in cursive script, appearing to read "Ray".

REPORT ON THE PALYNOSTRATIGRAPHY OF THE GCB2 WELL, SAVANNAH RIVER SITE

submitted by R. A. Christopher
October 8, 1996

SUMMARY

Twenty samples from the GCB-2 well were sampled, processed, and analyzed for palynomorphs; no age significant fossils were recovered from any of the samples, and no age determinations can be made.

Extremely rare palynomorphs and/or palynomorph fragments were observed in 5 of the samples; in addition, the organic material recovered from an additional 9 of the 20 samples was so low that only 1 kerogen slide and no biostratigraphic slides could be made for these samples. Both kerogen and biostratigraphic slides were made for the remaining 6 samples, all of which were barren of palynomorphs.

BIOSTRATIGRAPHY

The samples taken from the GCB-2 well and the corresponding results are as follows:

95'-0"	Only 1 kerogen slide made; barren of palynomorphs
96'-0"	Only 1 kerogen slide made; barren of palynomorphs
108'-0"	Only 1 kerogen slide made; barren of palynomorphs
123'-0"	Only 1 kerogen slide made; barren of palynomorphs
154'-0"	Barren of palynomorphs
154'-3"	Barren of palynomorphs
185'-10"	Barren of recognizable palynomorphs
189'-5"	Contains the following palynomorphs <i>Pityosporites</i> sp. <i>Deltoidospora</i> sp. indeterminate tricolpate
267'-0"	Only 1 kerogen slide made; barren of palynomorphs
409'-0"	Barren of palynomorphs
411'-0"	Barren of palynomorphs
412'-4"	One palynomorph fragment observed: ?Inaperturate
415'-6"	One palynomorph fragment observed: indeterminate
416'-6"	One palynomorph observed: <i>Pityosporites</i>
504'-3"	Only 1 kerogen slide made; barren of palynomorphs
609'-0"	Contains the following palynomorphs <i>Pityosporites</i> sp. <i>Cyathidites</i> sp.

614'-2"	Only 1 kerogen slide made; barren of palynomorphs
628'-3"	Only 1 kerogen slide made; barren of palynomorphs
630'-6"	Only 1 kerogen slide made; barren of palynomorphs
643'-0"	Only 1 kerogen slide made; barren of palynomorphs

Please call if you have any questions regarding this report.

Respectfully submitted,

Raymond A. Christopher

cc: R. S. Van Pelt

CLEMSON

UNIVERSITY

September 11, 1996

Mr. Mitch Alberts
ARCO Paleo Lab
1601 Summit Avenue
Plano, Texas 75074

Dear Mitch:

Enclosed are 16 samples from the Cretaceous section of a recently cored well located in South Carolina. Please process the samples for palynomorphs, bearing in mind that any microflora recovered will most likely contain small (10 micrometer) angiosperm pollen.

The well designation is GCB-2, and the depths at which the samples were taken are:

154'-0"	267'-0"	415'-6"	614'-2"
154'-3"	409'-0"	416'-6"	628'-3"
185'-10"	411'-0"	504'-3"	630'-6"
189'-5"	412'-4"	609'-0"	643'-0"

Please include the well designation and sample depth on the slide labels. For each sample, I will need two slides prepared for biostratigraphic analysis, and one slide for kerogen/maturation analysis.

There is no need to return the unprocessed sample material, but I am required to return the processed residue and prepared slides to Westinghouse Savannah River Company, so please forward the residues together with the slides when you've completed the processing.

Thanks for your help, Mitch. Please give my best to Steve, Frank, and Charles.

Regards,

Raymond A. Christopher
enclosures
cc: R. S. Van Pelt
D. Wyatt

DEPARTMENT OF GEOLOGICAL SCIENCES

College of Engineering & Science School of the Environment 340 Brackett Hall Box 341908 Clemson, SC 29634-1908

864.656.3438 FAX 864.656.1041

Borrowed from WSRC 8/15/96
 WSRC Contact: Doug Wyatt
 Clemson Contact: Ray Christopher

GCB2 CORE

BOX NUMBER	DEPTH RANGE (ft.)	COMMENTS
14	141-150	
15	150-160	Paly sample at: 154.0, 154.25
16	160-170	
17	170-180	
18	180-189'-5"	Paly sample at: 185.8
19	189'-5"-197	Paly sample at: 189.4
20	197-206'-6"	
21	206'-6"-216'-6"	
22	216'-6"-226'-6"	
23	226'-6"-236'-6"	
24	236'-6"-246'-6"	
25	246'-6"-256'-2"	
26A	256'-2"-266	
26	266-276	Paly sample at: 267.0
27	276-286	
28	286-296	
29	296-306	
30	306-316	
31	316-326	
32	326-336	
33	336-346	
34	346-356	
35	356-366	
36	366-376	
37	376-386	
38	386-396	
39	396-406	
40	406-416	Paly sample at: 409.0, 411.0, 412.3, 415.5
41	416-426	Paly sample at: 416.5
42	426-436	
43	436-446	
44	446-456	
45	456-466	
46	466-476	
47	476-486	
48	486-495	
49	495-505	Paly sample at: 504.25
50	505-515	
51	515-525	
52*	525-535	
52*	535-545	
54	545-555	
55	555-565	
56	565-575	

Borrowed from WSRC 8/15/96
 WSRC Contact: Doug Wyatt
 Clemson Contact: Ray Christopher

GCB2 CORE

57	575-585	
58	585-595	
59	595-605	
60	605-614'-2"	Paly sample at: 609.0
61	614'-2"-624	Paly sample at: 614.2
62	624-634	Paly sample at: 628.25, 630.6
63	634-644	Paly sample at: 634.0
64	644-654	Thin sections at: 644.0-644.2, 645.2-645.4, 650.5-650.8
65	654-664	
66	664-674	
67	674-683	
68	683-684	
* Note duplication of box number		

CLEMSON

U N I V E R S I T Y

September 24, 1996

Doug Wyatt
Westinghouse Savannah River Company
Building 720-2B Room 1076
Aiken, South Carolina 29808

Dear Doug,

Enclosed is my report on the GCB1A sample (439'-6"). It's unfortunate that we have only one sample from the well, especially since this one is apparently "unique" in its stratigraphic position.

I expect the processing of the GCB2 samples to be completed in a couple of weeks, and I will let you know the schedule for the analysis and reporting of these samples when the prepared slides are returned.

Katherine informed me that you recovered a bone fragment from one of the wells, and that you're interested in identifying someone who might be able to help. There's a guy at NC State who's quite a renowned dinosaur expert, and I've been corresponding with him these past few months. I haven't been able to contact him as yet, but I'm confident that he'd be interested in looking at the sample. When I've talked with him, I'll get back to you.

Please let me know if you have any questions about the enclosed report.

Regards,

Raymond A. Christopher
enclosure
cc: R. S. Van Pelt

DEPARTMENT OF GEOLOGICAL SCIENCES

College of Engineering & Science School of the Environment 340 Brackett Hall Box 341908 Clemson, SC 29634-1908

864.656.3438 FAX 864.656.1041

REPORT ON THE PALYNOSTRATIGRAPHY OF A SAMPLE FROM 439'-6", GCB1A WELL, SAVANNAH RIVER SITE

submitted by R. A. Christopher
September 23, 1996

SUMMARY

One sample from the GCB1A well was taken from a 4-inch thick, dark gray, laminated, slightly micaceous silty clay; the sample was processed and analyzed for palynomorphs with the following results:

- o The unit is late Campanian to early Maastrichtian in age, equivalent to calcareous nannofossil zones CC23/24. As such, the unit occupies a stratigraphic position that is represented by a major unconformity in downdip wells (e.g., by an unconformity that occurs between 586 ft and 601 ft in the P21TA well, and between 886 and 94 ft in the C10 well).
- o The depositional environment of the unit is nonmarine, as evidenced by the abundance of nonmarine spores, pollen, plant cuticle, wood fibers, and inertinite, and by the absence of marine algae (dinoflagellates) and amorphous kerogen.

BIOSTRATIGRAPHY

Age Assignment

A late Campanian to early Maastrichtian age for the sample from 439'-6" in the GCB1A well is based on a comparison of its contained assemblage of spores and pollen with the unpublished palynological zonation developed by the writer for the Upper Cretaceous Series of the southeastern U.S. This zonation and associated ages, calcareous nannofossil zones, lithostratigraphic units as identified in the Clubhouse Crossroads #1 core, and palynomorph markers, is illustrated in Figure 1.

The GCB1A sample at 439'-6" appears to occupy a stratigraphic position between zones A and B (see Figure 1). In downdip (i.e., coastal) wells, calcareous nannofossil data indicate the consistent presence of an unconformity at this horizon (Self-Trail, oral and written communication; Gohn, oral communication). Palynologically, the differences between zones A and B in downdip wells is readily apparent, based on the marker fossils indicated in Figure 1, and by additional criteria (i.e., other marker fossils, abundance changes, changes in the dominant pollen type or group).

The pollen assemblage from the GCB1A well, however, contains elements of both zones A and B. Absent from the sample are the markers for both zone A (*Plicatopollis cretacea*, N15-31a) and zone B (?*Holkopollenites* sp., *Osculapollis aequala*). But forms that range through both zones are present in the sample (e.g., *Plicapollis usitata* late

form, *Baculostephanocolpites* sp. A). In addition, a common to frequent element of the lower zone A assemblage is an unpublished species of *Momipites* that is cataloged as N15-30. This form is smooth, both tumescent and annulate, and is easily identified even under low magnification. In the GCB1A sample, two specimens of N15-30 were observed, and in both specimens, the tumescence and annuli were weakly developed, and the surface was coarsely scabrate; these forms were interpreted as "early" forms of N15-30. Also present in the GCB1A sample is an unusual pollen type (undescribed pollen type, Table 1) that was also observed in the basal zone A sample in the P21TA well (at 586 ft).

Depositional Environment

The palynomorph taxa observed in the GCB1A sample from 439'-6", and their relative abundances (based on a count of more than 350 palynomorphs), is presented in Table 1. All palynomorphs are of terrestrial origin, indicating a nonmarine depositional environment. This interpretation is supported by the presence of large fragments of plant cuticle, wood fibers, isolated bordered pits, and inertinite, which comprises approximately 50 per cent of the non-palynomorph kerogen types.

As evidenced by the data in Table 1, the assemblage is dominated by gymnosperm pollen (> 50% of the assemblage), with the Cretaceous index fossil *Rugubivesiculites* spp. comprising nearly one-quarter of the entire assemblage. Angiosperm pollen comprise an additional one-quarter of the assemblage, and this microflora is diverse but lacks an overwhelmingly dominant form. Fern spores (10%) and fungal spores (13%) comprise the remainder of the assemblage.

The absence of marine elements, the dominance of gymnosperm pollen, the low percentage of fern spores, and the diverse angiosperm pollen suggests a terrestrial depositional environment that was well drained, and one that most likely received both air- and water-borne elements that were subject to long-distance transport.

Please contact me if you should have any questions regarding this report.

Respectfully submitted,

Raymond A. Christopher
Department of Geological Sciences
Clemson University
Clemson, SC 29634-1908
(864) 656-1897

Figure 1. Palynologic zonation of the Upper Cretaceous Series of the southeastern U.S. The ages, position and duration of unconformities, and lithostratigraphic equivalents are based on calcareous nannofossil data from several downdip wells. It should be noted that each pollen zone is characterized by additional taxa and by abundance data that are not included on the figure (refer to text for a discussion of some of these additional characteristics). Alphanumeric characters in parentheses following a binomen refer either to the code(s) used by Wolfe (1976) or by the writer (unpublished). Biostratigraphic datums identified only by alphanumeric codes refer to taxa that have not been cited in the published literature.

Figure 1.

Table 1. Relative frequency of palynomorphs observed in the GCB1A sample at 439'-6". Relative frequencies are presented as percentage data, based on a count of 360 palynomorphs. Those taxa whose abundance is represented by an "X" are present in the sample, but were not observed during the count of 360 grains.

Table 1.

GCB1A Sample at 439'-6"

Angiosperm pollen	24.62%
Asteropollis sp. (small form)	0.61%
Undifferentiated tricolpates (C3)	2.74%
Undifferentiated tricolporates (CP3)	6.38%
Undescribed tricolporate form CP3-107	x
Nyssapollenites sp. A (CP3-20)	0.30%
Holkopollenites sp. (CP3-47a)	5.17%
aff. Holkopollenites sp. (CP3-85)	0.30%
Undescribed tricolporate form CP3-108	0.61%
Holkopollenites ?chemardensis (?CP3D-3)	x
Brevicolporites sp. B	0.30%
Ilexpollenites spp.	1.22%
Libopollis jarzenii (CP3-124)	x
Margocolporites aff. M. cribellatus (CP3-41)	3.04%
Baculostephanocolpites sp. A	0.61%
Baculostephanocolpites sp. B	x
Nyssapollenites spp.	0.91%
Minorpollis sp. (N11-2)	x
?Momipites sp. (N15-30)	0.30%
Casuarinidites sp. (N20-2)	x
Pseudoplicapollis serena (NC-3)	x
Plicapollis usitata (NE-3 late form)	x
Osculapollis aff. O. perspecta (NO-4)	x
Proteacidites spp. (PR)	1.52%
Sabalpollenites sp.	0.61%
Undescribed tetracolporate form	x
Gymnosperm pollen	51.67%
Bisaccates	34.65%
Cedripites spp.	2.74%
Parvisaccites spp.	1.52%
Phyllocladidites spp.	0.61%
Pityosporites spp.	6.69%
Podocarpidites spp.	0.30%
Rugubivesiculites spp.	22.80%
Nonbisaccates	17.02%
Araucariacites aff. A. australis	17.02%
Classopollis sp.	x
Inaerturopollenites spp.	7.90%
Sequoiaepollenites sp.	x
Taxodiaceapollenites hiatus	7.90%
Spores	10.03%
Camerozonosporites spp.	x
Cicatricosisporites spp.	0.30%
Cyathidites major	1.82%
Cyathidites minor	x
Deltoidospora hallii	x
Dictyophyllidites sp.	2.74%
Laevigatosporites spp.	4.86%
aff. Aratrisporites monosaccatus (M-9)	x
Nevesisporites sp.	x
Stereisporites sp.	0.30%
Indeterminate affinity	0.61%
Undescribed monocolpate	x
Perinopollenites sp.	0.61%
Fungal spores	
Fungal spores	13.07%

(x = present, but outside the count)

REFERENCES CITED

- Wolfe, J. A., 1976, Stratigraphic distribution of some pollen types from the Campanian and lower Maestrichtian rocks (Upper Cretaceous) of the Middle Atlantic States: U.S. Geological Survey Professional Paper 977, 18p., 4 pls., 3 text-figs., 2 tables.

WSRC-RP-97-0185

Revision 0

June, 1997

Appendix D
Core Plug VOC Data for GCB-1, 2, 3

WSRC-RP-97-0185

Revision 0

June, 1997

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MICROSEEPS

961808

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 8 -----
 ----- SOIL CONCENTRAIONS IN (NG/G) -----

SAMPLE NAME	BENZENE	TOLUENE	ETHYL BENZENE	M&P- XYLENE	O- XYLENE	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
GCB2-01	<2	9	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	0.4	0.2	B14 224
GCB2-02	<2	<2	<2	<2	<2	<100	<50	<1	0.6	<.1	<.1	0.4	0.3	B14 225
GCB2-03	<2	<2	<2	<2	<2	<100	<50	<1	0.6	<.1	<.1	0.3	0.2	B14 226
GCB2-04	<2	<2	<2	<2	<2	<100	<50	<1	0.6	<.1	<.1	0.5	0.3	B14 227
GCB2-05	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 239
GCB2-06	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	0.5	0.4	B14 240
GCB2-07	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 274
GCB2-08	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 275
GCB2-09	<2	<2	<2	<2	<2	<100	<50	<1	0.1	0.2	<.1	<.1	<.1	B14 276
GCB2-10	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 277
GCB2-10 DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 278
GCB2-11	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 280
GCB2-12	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	0.4	0.2	B14 241
GCB2-13	<2	<2	<2	<2	<2	<100	<50	<1	0.1	0.2	<.1	<.1	<.1	B14 242
GCB2-14	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 243
GCB2-15	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.2	<.1	<.1	<.1	B14 244
GCB2-16	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 245
GCB2-17	<2	10	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 246
GCB2-18	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 247
GCB2-19	<2	<2	<2	<2	<2	<100	<50	<1	0.1	0.1	<.1	<.1	<.1	B14 248
GCB2-20	<2	3	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 249
GCB2-20 DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 250
GCB2-21	<2	<2	<2	<2	<2	<100	<50	<1	0.4	0.2	<.1	<.1	<.1	B14 253
GCB2-22	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 254
GCB2-23	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 255
GCB2-24	<2	<2	<2	<2	<2	<100	<50	<1	<.1	0.1	<.1	<.1	<.1	B14 256

22-Jul-96

MICROSEEPS

961808

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 8 -----
 ----- SOIL CONCENTRATIONS IN (NG/G) -----

SAMPLE NAME	BENZENE	TOLUENE	ETHYL BENZENE	M&P- XYLENE	O- XYLENE	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
GC82-25	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 257
GC82-26	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 258
GC82-27	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 259
GC82-28	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 260
GC82-29	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 261
GC82-30	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 262
GC82-30 DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 263
GC82-31	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 266
GC82-32	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 267
GC82-33	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 268
GC82-34	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 269
GC82-35	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	0.1	0.1	B14 270
GC82-36	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 271
GC82-37	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 272
GC82-38	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 282
GC82-39	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 283
GC82-40	<2	3	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 284
GC82-40 DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 285
GC82-41	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 286
GC82-42	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 287
GC82-43	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 288
GC82-44	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 289
GC83-45	<2	35	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 348
GC83-46	<2	7	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 349
GC83-47	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 350
GC83-48	<2	35	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 351

22-Jul-96

MICROSEEPS

961808

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 8 -----
 ----- SOIL CONCENTRAIONS IN (NG/G) -----

SAMPLE NAME			ETHYL	M&P-	O-	VINYL	METHYLENE	t-1,2-	CHLORO	1,1,1-	CARBON	TRI	TETRA	FILE NAME
	BENZENE	TOLUENE	BENZENE	XYLENE	XYLENE	CHLORIDE	CHLORIDE	DCE	FORM	TCA	CHLORIDE	ETHYLENE	CHLORO ETHLENE	
GCB3-49	<2	7	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 352
GCB3-50	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 353
GCB3-50DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 354
GCB3-51	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 358
GCB3-52	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 359
GCB3-53	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 360
GCB3-54	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 361
GCB3-55	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 362
GCB3-56	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 363
GCB3-57	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 364
GCB3-58	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 365
GCB3-59	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 366
GCB3-60	<2	6	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 377
GCB3-60DUP	<2	6	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 378
GCB3-61	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 380
GCB3-62	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 381
GCB3-63	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 382
GCB3-64	<2	4	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 383
GCB3-65	<2	3	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 384
GCB3-66	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 394
GCB3-67	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 395
GCB3-68	<2	3	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 396
GCB3-69	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 397
GCB3-70	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 398
GCB3-70(DUP)	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 399
GCB3-71	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 400

22-Jul-96

MICROSEEPS

961808

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 8 -----
 ----- SOIL CONCENTRAIONS IN (NG/G) -----

SAMPLE NAME	BENZENE	TOLUENE	ETHYL BENZENE	M&P- XYLENE	O- XYLENE	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
GCB3-72	<2	4	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 401
GCB3-73	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 402
GCB3-74	<2	43	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 408
GCB3-75	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 409
GCB2-SB01	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 223
GCB2-SB02	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 279
GCB2-SB03	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 252
GCB2-SB04	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 265
GCB2-SB05	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 290
GCB3-SB06	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 357
GCB3-SB07	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 379
GCB3-SB08	<2	<2	<2	<2	<2	<100	<50	<1	0.2	0.2	<.1	<.1	<.1	B14 393

22-Jul-96

961810

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 10 -----
 ----- SOIL CONCENTRATIONS IN (NG/G) -----

SAMPLE NAME			ETHYL	M&P-	O-	VINYL METHYLENE	t-1,2-	CHLORO	CARBON		TRI	TETRA	FILE NAME
	BENZENE	TOLUENE	BENZENE	XYLENE	XYLENE	CHLORIDE	CHLORIDE	FORM	1,1,1- TCA	TETRA CHLORIDE	CHLORO ETHYLENE	CHLORO ETHYLENE	
GCB3-76	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 410
GCB3-77	<2	2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 411
GCB3-78	<2	2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 412
GCB3-79	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 413
GCB3-80	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 414
GCB3-80DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 415
GCB3-81	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 419
GCB3-82	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 420
GCB3-83	<2	3	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 421
GCB3-84	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 422
GCB3-85	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 423
GCB3-86	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 424
GCB3-87	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 425
GCB3-88	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 426
GCB3-89	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 427
GCB3-90	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 428
GCB3-90DUP	<2	<2	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	B14 429
GCB1-91	<2	6	<2	<2	<2	<100	<50	<1	0.8	<.1	<.1	<.1	B14 462
GCB1-92	<2	2	<2	<2	<2	<100	<50	<1	1.0	<.1	<.1	<.1	B14 463
GCB1-93	<2	5	<2	<2	<2	<100	<50	<1	0.9	<.1	<.1	<.1	B14 464
GCB1-94	<2	4	<2	<2	<2	<100	<50	<1	0.9	<.1	<.1	<.1	B14 465
GCB1-95	<2	<2	<2	<2	<2	<100	<50	<1	0.8	<.1	<.1	<.1	B14 466
GCB1-96	<2	<2	<2	<2	<2	<100	<50	<1	0.8	<.1	0.1	0.2	B14 467
GCB1-97	<2	102	<2	<2	<2	<100	<50	<1	1.3	<.1	0.6	0.5	B14 468
GCB1-98	<2	66	<2	<2	<2	<100	<50	<1	1.2	<.1	<.1	<.1	B14 469
GCB1-99	<2	3	<2	<2	<2	<100	<50	<1	0.9	<.1	0.3	<.1	B14 470
GCB1-100	<2	3	<2	<2	<2	<100	<50	<1	1.1	<.1	1.0	0.4	B14 471
GCB1-100DUP	<2	3	<2	<2	<2	<100	<50	<1	1.1	<.1	0.8	0.4	B14 472
GCB1-101	<2	6	<2	<2	<2	<100	<50	<1	1.0	<.1	5.5	1.6	B14 476
GCB1-102	<2	5	<2	<2	<2	<100	<50	<1	1.3	<.1	0.3	<.1	B14 477

961810

----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 10 -----
 ----- SOIL CONCENTRAIONS IN (NG/G) -----

SAMPLE NAME	BENZENE	TOLUENE	ETHYL BENZENE	M&P- XYLENE	O- XYLENE	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
GCB1-103	<2	9	<2	<2	<2	<100	<50	<1	1.2	<.1	<.1	2.0	0.1	B14 478
GCB3-104	<2	131	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 479
GCB3-105	<2	16	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 480
GCB3-106	<2	10	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 481
GCB3-107	<2	15	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B14 482
GCB3-108	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 48
GCB3-109	<2	<2	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 49
GCB3-110	<2	<2	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 50
GCB3-110DUP	<2	<2	<2	<2	<2	<100	<50	<1	0.6	<.1	<.1	<.1	<.1	B15 51
GCB3-111	<2	157	<2	<2	<2	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 53
GCB3-112	<2	10	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 54
GCB3-113	<2	3	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 55
GCB3-114	<2	10	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 56
GCB3-115	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 57
GCB3-116	<2	4	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 80
GCB3-117	<2	4	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 81
GCB3-118	<2	2	<2	<2	<2	<100	<50	<1	0.1	<.1	<.1	<.1	<.1	B15 82
GCB3-119	<2	9	<2	<2	<2	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B15 83
GCB3-120	<2	5	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 84
GCB3-120DUP	<2	2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 85
GCB3-121	<2	<2	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 87
GCB3-122	<2	6	<2	<2	<2	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 88
GCB3-123	<2	5	<2	<2	<2	<100	<50	<1	0.8	<.1	<.1	<.1	<.1	B15 89
GCB3-124	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 90
GCB1-125	<2	2	<2	<2	<2	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B15 127
GCB1-126	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 128
GCB1-127	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 129
GCB1-128	<2	<2	<2	<2	<2	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 130
GCB1-129	<2	<2	<2	<2	<2	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 131
GCB1-130	<2	<2	<2	<2	<2	<100	<50	<1	1.0	<.1	<.1	<.1	<.1	B15 132

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----- SAVANNAH RIVER SITE -----
 ----- PROJECT: RELEASE 7 -----
 ----- WATER CONCENTRATIONS (UG/L) -----

SAMPLE NAME	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
IDWGC82-01	<100	<50	<1	2.9	<.1	<.1	<.1	<.1	B14 191
IDWGC82-02	<100	<50	<1	2.9	<.1	<.1	<.1	<.1	B14 192
IDWGC82-03	<100	<50	<1	1.6	<.1	<.1	<.1	<.1	B14 220
IDWGC82-04	<100	<50	<1	1.6	<.1	<.1	<.1	<.1	B14 221
IDWGC82-05	<100	<50	<1	1.7	<.1	<.1	<.1	<.1	B14 222
IDWGC82-06	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 293
IDWGC82-07	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 303
IDWGC83-08	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 345
IDWGC83-09	<100	<50	<1	0.3	<.1	<.1	<.1	<.1	B14 346
IDWGC83-10	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B14 347
IDWGC83-11	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 371
IDWGC83-11DUP	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 372
IDWGC83-12	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B14 389
IDWGC81-13	<100	<50	<1	1.3	<.1	<.1	<.1	<.1	B14 454
IDWGC81-14	<100	<50	<1	1.2	<.1	<.1	<.1	<.1	B14 455
IDWGC81-15	<100	<50	<1	0.9	<.1	<.1	<.1	<.1	B14 456
IDWGC81-16	<100	<50	<1	1.3	<.1	<.1	0.1	0.3	B14 457
IDWGC81-17	<100	<50	<1	1.1	<.1	<.1	0.3	0.3	B14 458
IDWGC81-18	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 34
IDWGC81-19	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 35
IDWGC81-20	<100	<50	<1	0.6	<.1	<.1	<.1	<.1	B15 36
IDWGC81-20DUP	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 37
IDWGC81-21	<100	<50	<1	0.6	<.1	<.1	<.1	<.1	B15 39
IDWGC81-22	<100	<50	<1	1.2	<.1	<.1	<.1	<.1	B15 40
IDWGC81-23	<100	<50	<1	1.0	<.1	<.1	<.1	<.1	B15 41
IDWGC81-24	<100	<50	<1	0.6	<.1	<.1	<.1	<.1	B15 42
IDWGC81-25	<100	<50	<1	2.4	<.1	<.1	<.1	<.1	B15 43
IDWGC81-26	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 62
IDWGC81-27	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 66
IDWGC81-28	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 67
IDWGC81-29	<100	<50	<1	0.4	<.1	<.1	<.1	<.1	B15 68
IDWGC81-30	<100	<50	<1	0.7	<.1	<.1	<.1	<.1	B15 69
IDWGC81-30DUP	<100	<50	<1	0.7	<.1	<.1	<.1	<.1	B15 70
IDWGC81-31	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 72
IDWGC81-32	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 73
IDWGC81-33	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 74
IDWGC81-34	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 75
IDWGC81-35	<100	<50	<1	0.5	<.1	<.1	<.1	<.1	B15 76
IDWGC81-36	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 105
IDWGC81-37	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 106
IDWGC81-38	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 107
IDWGC81-39	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 108
IDWGC81-40	<100	<50	<1	0.1	<.1	<.1	<.1	<.1	B15 109
IDWGC81-40DUP	<100	<50	<1	0.1	<.1	<.1	<.1	<.1	B15 110
IDWGC81-41	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 113
IDWGC81-42	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 114
IDWGC81-43	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 115
IDWGC81-44	<100	<50	<1	0.1	<.1	<.1	<.1	<.1	B15 116
IDWGC81-45	<100	<50	<1	0.1	<.1	<.1	<.1	<.1	B15 117
IDWGC81-46	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 118

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----- SAVANNAH RIVER SITE -----
----- PROJECT: RELEASE 7 -----
----- WATER CONCENTRATIONS (UG/L) -----

SAMPLE NAME	VINYL CHLORIDE	METHYLENE CHLORIDE	t-1,2- DCE	CHLORO FORM	1,1,1- TCA	CARBON TETRA CHLORIDE	TRI CHLORO ETHYLENE	TETRA CHLORO ETHYLENE	FILE NAME
IDWGCB1-47	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 119
IDWGCB1-48	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 120
IDWGCB1-49	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 121
IDWGCB1-50	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 122
IDWGCB1-50DUP	<100	<50	<1	0.2	<.1	<.1	<.1	<.1	B15 123
IDWGCB2-SB01	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 190
IDWGCB3-SB02	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B14 388
IDWGCB1-SB03	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B15 38
IDWGCB1-SB04	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B15 71
IDWGCB1-SB05	<100	<50	<1	<.1	<.1	<.1	<.1	<.1	B15 111