Analysis of Lithologic Properties and Permeability Values in Closely Spaced Cores from the Tonganoxie Sandstone, Wyandotte County, Kansas

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Introduction

This report summarizes the results of a coring study that examined ten closely spaced, near subsurface cores (NE SW NW, Sec. 8, T11S, R23E) in Wyandotte County, Kansas (Figure 1). These cores were drilled through the Tonganoxie Sandstone Member of the Stranger Formation (Upper Pennsylvanian, Douglas Group) behind the fluvial outcrop study site of Beaty et al. (1997) (Figure 2). The outcrop at the study site provided an opportunity to examine contacts between sandstone sets, analyze changes in grain size and mica distribution, and make closely spaced measurements of permeability at an interwell-scale. However, examination of the two-dimensional exposure provided little information about these properties away from the outcrop face. Study of the closely spaced cores made it possible to analyze the three-dimensional distribution of *in situ* air permeability (K_a) and lithologic types, such as sandstone and conglomerate, at an interwell-scale.

The Tonganoxie Sandstone accumulated within an incised paleovalley that extended across much of eastern Kansas during the early Virgilian (Figure 1). The valley-fill succession consists of very fine- to fine-grained sandstone facies overlain by a regionally developed succession of interbedded, heterolithic sandstone, siltstone, and shale facies (Archer et al. 1994; Feldman et al. 1995; Beaty, *in prep.*). Feldman et al. (1995) interpreted the depositional environments of sandstone facies in the Tonganoxie valley-fill. They divided the Tonganoxie Sandstone into four stratigraphic types: a basal conglomerate and braided-fluvial sheet sandstone (type 1), arcuate to sinuous estuarine point bar and channel sandstone (type 2), elongate pods of valley-head delta sandstone (type 3), and thin, discontinuous shallow marine sheet sandstone (type 4). Archer et al. (1994) described the stratigraphic architecture of Douglas Group sandstones and placed the Tonganoxie interval into a sequence stratigraphic framework. The Tonganoxie Sandstone is an important groundwater aquifer (O'Conner 1960), and is an analog for sandstone hydrocarbon reservoirs with similar architectural and petrologic characteristics (Beaty, *in prep.*).

Outcrop Description

Archer et al. (1993) determined that the sandstone at the outcrop was deposited in a type 1 fluvial setting. Beaty et al. (1997) analyzed $\mathbf{K_a}$ values and petrologic attributes of the sandstone. They divided the sandstone vertically into two intervals with similar characteristics. They determined that the hydrodynamic properties of the intervals were distinctively different, warranting their division into an upper and a lower flow unit.

The lower flow unit consists of trough cross-bedded (*St*) sets (Figure 3) in channel (CH) architectural elements (c.f. Miall 1985). Cross-cutting *St* sets are the result of repeated scouring and filling during sandstone deposition. The *St* sets contain very fine- to fine-grained, micaceous quartz sandstone. Small-scale studies of the outcrop face reveal that mica was more concentrated at the base of the *St* sets in lamina near trough scours, than in upper portions of the sets (Beaty et al. 1997; Beaty, *in prep.*). Beaty et al. (1997) used ground-penetrating radar (GPR) data from a grid of vertical profiles to determine the width and orientation of *St* sets and CH elements. The *St* sets are 5 to 10 m (16.4 to 32.8 ft) across and generally decrease in width upward. The axes of trough and channel scours trend toward the southeast, suggesting that the local paleotransport direction was parallel to this direction (Beaty et al. 1997).

The upper flow unit consists of *St* sets and low angle cross-bedded (*Sl*) sets containing silty, very fine- to fine-grained, highly micaceous quartz sandstone. Upper flow unit *St* sets are not as wide as lower flow unit *St* sets and are typically less than 5 m (16.4 ft) across. In the upper flow unit, trough axes of *St* sets have orientations that range from southeast to southwest.

At an exposure across the highway from the sandstone outcrop of Beaty et al. (1997), a conglomerate interval is present at the base of the Tonganoxie Sandstone above the lower sequence boundary of the Tonganoxie sequence (Archer et al. 1994). The conglomerate interval, which overlies 0.08 to 0.15 m (0.25 to 0.50 ft) of Weston Shale, consists of a 1 to 1.3 m (3.3 to 4.3 ft) interbedded succession of conglomerate, conglomeratic sandstone, and minor sandstone. This interval is commonly cemented with calcite and iron oxide or hydroxide, and has an undulating upper surface. Of the

lithologic types present, conglomerate beds dominate the succession. Some of the conglomerate beds are laterally continuous and can be traced for distances greater than 20 m (66 ft) along the outcrop face. These beds consist of a bimodal assemblage of granule to pebble-sized shale, limestone, and limonitic shale clasts, and minor wood fragments within a matrix of very fine- to fine-grained quartz sand. In conglomerate beds, clasts consist mostly of angular limestone ftagments and lesser amounts of angular shale fragments that are up to 7 cm long. Clast abundance in these beds ranges from 20% to 70%. Clast sizes vary from bed to bed, with granular clasts dominant in some beds and angular pebble-sized clasts dominant in others. In conglomeratic sandstone beds, clasts are mostly less than 1 cm long and consist of rounded shale fragments and lesser amounts of angular limestone fragments.

Methods

Ten 6.4 cm (2.5 incb) diameter cores were drilled in a 4500 m^2 area (48,200 ft^2) in the field behind the outcrop site (Figure 4). Six of the cores were drilled 16 m apart along an 80-meter-long northeast-trending transect. The other four cores were drilled 28 m away from the 6-core transect; two to the northwest and two to the southeast of the transect (Figure 4). Core T132 P014 was drilled approximately 18 m from the outcrop face and northeast of outcrop permeability Station 250. An outcrop profile containing permeability Station 250 is shown in Figure 3.

In the drill holes, wireline logs were used to determine conductivity and gamma ray valucs. Wireline log gamma ray and conductivity values from each hole are plotted as graphs on the core descriptions shown in Appendix 1 and in Plate 1.

A Temco Model MP-400 Electronic Field Gas Permeameter (minipermeameter) was used to make measurements of $\mathbf{K_a}$ values along the length of the cores. These $\mathbf{K_a}$ measurements were made at intervals that ranged from 7.5 cm to 15 cm (3 to 6 inches). Data collection and analysis methods for minipermeameter measurements are described in Beaty (*in prep.*). Appendix 2 includes the values of $\mathbf{K_a}$ determined with the minipermeameter and includes data used to calculate the values. Graphs of

these K_a values are shown on the left side of core descriptions in Appendix 1 and on the right side of the respective core description in Plate 1.

Horizontal K_a, porosity, and grain density values were measured for 37 plug samples drilled at 30.5 cm intervals (+ or – 6 cm) from cores T104 P014 and T132 P014, and for 8 plug samples from cores T104 P062 and T104 P078. In the laboratory, a permeameter equipped with a Hassler-type sample chamber was used to measure K_a values for the cores, and a helium porosimeter was used to measure porosity and grain density. Porosity, grain density, and K_a values for these plug samples were calculated using equations described in Beaty (*in prep.*). The minipermeameter was also used to measure K_a values for the plug samples and the results were compared with those obtained using the laboratory permeameter. Appendix 3 contains values of K_a that were obtained using these two instruments on plugs from cores T104 P014 and T132 P014.

Thin sections were produced from the material trimmed off of the end of 44 of the plug samples. The locations where plug samples and thin-section samples were extracted from the cores are indicated in Plate 1 and Appendix 1. Thin sections were analyzed using standard petrographic techniques (Williams et al. 1982). Appendix 4 contains the results of thin section analyses of plugs from cores T104 P014 and T132 P014. Parameters that were analyzed in the thin sections included grain size, sphericity, rounding, and sorting. The values of sphericity, rounding, and sorting were estimated using thin section comparison photomicrographs and charts provided by Beard and Weyl (1973). In four areas of each slide, mica, clay and cement percentages were estimated by comparison to charts (Williams et al. 1982). A micrometer scale was used to measure grain sizes in four areas of each slide, and approximately 80 grain size measurements in each slide were averaged (Appendix 4). Because the values of all of these analyses are approximations, they are only used to examine vertical trends.

Results of Analyses

Appendix 1 contains descriptions of the lithology and general sedimentary features of all ten cores. Core descriptions note prominent bounding surfaces, and contain qualitative assessments of mica content and grain size. The results of these macroscopic analyses were similar to the results of thin section estimates of mica content and grain size.

All of the cores were drilled through the South Bend Limestone and contained the lower sequence boundary of the Tonganoxie Sandstone. As in the conglomerate, the lower sequence boundary in the cores directly overlies the Weston Shale (0.08 to 0.33 m (0.25 to 1.00 ft) thick). Lithologic types present in the cores include sandstone consisting of *St* and *Sl* sets, conglomerate, conglomeratic sandstone, and silty sandstone. The cores contain sandstone intervals from the lower and upper flow units described along the outcrop. An interval above the upper flow unit, not present at the outcrop, was observed in the cores. The interval above the upper flow unit generally consisted of *Sl* sets (Miall 1985), horizontal beds, and ripple beds. In the field where the cores were drilled, the uppermost sandstone interval is exposed on the surface. A core drilled in the center of the surface exposure (core T076 P046; Appendix 1) penetrated 1.5 m of sandstone from this uppermost interval.

In the cores, a total of 407 horizontal $\mathbf{K_a}$ values were measured in sandstone with less than 5% cement. The measurements were in sandstone from the lower flow unit, the upper flow unit, and the interval above the upper flow unit. Minipermeameter measurements ranged from 51 millidarcies (md) to 3916 md, with a geometric average of 1094 md and an interquartile range (IQR, the range between 25th and 75th percentile of values) of 1157 md. Horizontal $\mathbf{K_a}$ values in the lower flow unit ranged from 110 md to 3916 md, with a geometric average of 1310 md and an IQR of 1131 md. In the upper flow unit, horizontal $\mathbf{K_a}$ values ranged from 63 md to 3134 md with a geometric average of 1154 md and an IQR of 1475 md. In the interval above the upper flow unit, $\mathbf{K_a}$ values ranged from 50 md to 2435 md, with a geometric average of 680 md and an IQR of 504 md.

Both the upper and lower flow units contain varying quantities of muscovite mica (ranging from 0.5 to 8.5 %; Appendix 4), but upper flow unit sandstone sets commonly contain more mica than sets

in lower flow unit sandstone. Thin section estimates of mica content from the upper flow unit yielded values that range from 2.0% to 8.5%, with an arithmetic average of 4.6%. In samples the lower flow unit, mica content ranges from 0.5% to 5.3%, with an arithmetic average of 2.5%.

Vertical $\mathbf{K_a}$ measurements, made in the upper and lower flow units along the sandstone outcrop, ranged from 13 to 2100 md, with a geometric average of 833 md (Beaty et al. 1997). Vertical to horizontal $\mathbf{K_a}$ (V:H) ratios along the outcrop ranged from 0.18 to 1.0, with an arithmetic average of 0.70. Although horizontal $\mathbf{K_a}$ values were similar in the two flow units, vertical $\mathbf{K_a}$ values in the upper flow unit were lower than vertical $\mathbf{K_a}$ values in the lower flow unit. The lower vertical $\mathbf{K_a}$ values in the upper flow unit are attributed to the presence of micaceous lamina boundaries. In upper flow unit sandstone, lamina surfaces were greater than 0.5 mm thick and contained layers of very fine-grained quartz sand, quartz silt, and detrital mica. Mica grains in these layers were at times slightly overlapped. Where mica grains comprised greater than 50% of the volume of the layer, the platy grains formed continuous layers that could significantly affect fluid flow. Vertical permeability measurements perpendicular to these micaceous surfaces were relatively low (<300md) and V:H ratios in these laminated intervals generally ranged from 0.2 to 0.5. Much of the sandstone in the lower flow unit contain lamina surfaces with similar fine-grained, micaceous layers that are generally less than 0.5 mm thick. In many of the lamina, mica grains did not overlap to form continuous layers. However, presence of these layers did affect vertical fluid flow. The V:H ratios through lower flow unit lamina generally ranged from 0.6 to 1.0. Commonly, vertical permeability measurements perpendicular to lamina in the lower flow unit were equal to the corresponding horizontal measurement.

Cross-section Analysis

Cross-sections (Plate 1) were generated using data from core descriptions and wireline logs (Appendix 1), and $\mathbf{K_a}$ data (Appendix 2). The cross-sections contain lithologic descriptions of cores and include qualitative assessments of mica, iron oxide or hydroxide, and calcite cement. In addition, graphs of gamma ray, conductivity, and permeability values versus depth are shown. Cross-sections A-

A' and B-B' (Plate 1) depict cores drilled 28 m apart along southeast-trending transects that approximately parallel the local southeast paleo-transport direction (Beaty et al. 1997). Cross-section C-C' (Plate 1) depicts cores drilled 16 m apart along a northeast-trending transect, approximately perpendicular to the local transport direction. Intervals were correlated between cores in the cross-sections using information from core descriptions and wireline logs (Plate 1). In addition, line drawings of the outcrop photomosaic (Figure 3) were compared to correlation lines along cross-section A-A'. Profiles of GPR data from Beaty et al. (1997) were compared to correlation lines along cross-sections B-B' and C-C'. These comparisons made it possible to improve interpretations of the lateral extent of sandstone intervals and infer realistic sandstone geometries at the same scales observed along the outcrop.

Beaty et al. (1997) showed that *St* sets analyzed using the GPR grid are commonly less than 10 m (30.5 ft) wide when measured perpendicular to trough axes. It is important to note that at a minimum spacing of 16 m (52.5 ft), the cores were not close enough for correlation lines on the cross-sections to delineate all of the individual scour surfaces between *St* sets. Instead, many of the correlation lines, especially those that span the distance of the cross-sections, represent the boundaries between CH intervals that contain groups of *St* sets.

In addition to sandstone from the upper and lower flow units, approximately half of the cores also contained very fine-grained micaceous sandstone and silty sandstone from an interval above the upper flow unit. In comparison to sandstone in the upper and lower flow units, the uppermost sandstone interval contained a greater percentage of silt-sized quartz grains, generally contained greater than 6% mica and greater than 5% mud (detrital clay minerals), and exhibited lower horizontal $\mathbf{K_a}$ values. Some of the plane beds and *Sl* sets contained alternating thick and thin lamina and the ripple beds contained mud-draped reactivation surfaces. These beds extended throughout the GPR grid of Beaty et al. (1997), and could be correlated through cores in cross-sections B-B' and C-C' (Plate 1).

Many of the cores contained a basal conglomerate and conglomeratic sandstone interval similar to the one described earlier (p. 3). However, unlike that outcrop, conglomerate was not always the most

abundant lithologic type in this basal interval. The basal conglomerate and conglomeratic sandstone interval in cores varied in lateral thickness and contained clasts of varying sizes. Clast abundance generally ranged from 20% to 50%, although a few beds contained up to 70% clasts. Cross-section C-C' sbows that the basal conglomerate and conglomeratic sandstone interval has an undulating upper boundary. In most of the cores, the basal interval contains thin conglomerate beds (less than 15 cm) with 2 mm to 10 mm clasts. Most conglomerate beds could not be correlated between cores. Only three of the cores in cross-section C-C' contained beds with significant clast concentrations in the lower 15 cm (0.5 ft) of the interval, just above the sequence boundary.

Along the sandstone outcrop, a few thin, laterally discontinuous, conglomeratic sandstone beds were present at the base of trough scours. These types of thin conglomeratic sandstone beds were also observed in many of the cores. Like basal conglomerates, conglomeratic beds at bigher levels in the fluvial succession were extremely variable in thickness along the scour surface and clast abundance ranges from 20% to 50 %. In outcrop, upper conglomerates and conglomeratic sandstones were much more limited in extent (less than 3 m (9.8 ft)) than the basal conglomerates in the outcrop across the higbway.

Thin Section Analysis

Analysis of thin sections (Appendix 4) revealed that quartz grain size in the sandstone cores ranged from 0.09 mm (very fine-grained) to 0.17 mm (fine-grained). Beard and Weyl (1973) point out that thin section measurements of grain size tend to underestimate the actual grain size of samples. However, the results of the thin section grain size estimates are consistent with grain size sieve analyses performed on four *St* samples near the study site (Minor 1969). The thin section grain size measurements were sufficient to analyze vertical trends in grain size variation.

The thin sections contained subangular to subrounded and moderately sorted to very well sorted quartz grains (Appendix 4). Estimated mica content in the samples ranged from 0.5% to 8.5%, and averaged 2.5%. Estimated clay content in the samples ranged from 0.50% to 8.00% and averaged

3.4%. The highest amounts of clay were observed in samples containing shale clasts. Cements consisted of iron oxide and hydroxide in the upper portions of the cores and calcite and iron oxide and hydroxide cement in lower portions of the cores. Samples from intervals in the upper portions of the cores contained 2.0% to 5.0% iron oxide or hydroxide cement, and measured $\mathbf{K_a}$ values in these samples were generally greater than 1200 md. Measurements of $\mathbf{K_a}$ in calcite-cemented intervals near the base of the core commonly yielded values that were less than 1 md.

Wireline Log Analysis

Sandstone in the lower flow unit generally produces gamma ray intensity in the range of 40 to 70 counts per second (cps). Gamma ray values fluctuate with respect to position within *St* sets. As shown in the detailed core descriptions (Appendix 1), mica was a common constituent in these rocks. The magnitudes of gamma ray and conductivity values from the wireline logs corresponded roughly to qualitative assessments of mica and mud content observed in cores and in thin sections.

The conductivity and gamma ray logs provided information concerning the location of bounding surfaces. Intervals in the logs containing relatively small increases in conductivity (3-5 milli-Siemens/meter (mS/m) for 6-12 cm intervals) and shifts in gamma ray intensity (to values greater than 60 cps) corresponded to mica-rich bounding surfaces observed in core.

Core holes containing the upper flow unit had high gamma ray values. Core descriptions and thin section analyses demonstrated that this interval contained more mica, silt, and mud than sandstone from the lower flow unit. In the cores, the silty sandstone in the interval above the upper flow unit generally contains the most mica and generally exhibited the highest gamma ray values. Several of the core descriptions in Appendix I describe sandstone from this interval and the cross-sections in Plate 1 show that the lower contact of the interval is relatively flat.

Iron-rich zones (Fe oxides and hydroxides) identified in cores commonly exhibited conductivity values 10-20 mS/m higher than uncemented zones, while gamma ray values remained unchanged from those in uncemented zones. As iron-rich zones commonly have relatively low permeability values (<10

millidarcies (md)) and cause signal attenuation in GPR data (Martinez et al., *in review*), these findings have implications for evaluating the suitability of sites for near-surface GPR studies where wells logs are available but cores are not.

Comparison of K_a Measurement Techniques

In order to compare $\mathbf{K_a}$ values measured using minipermeameter and laboratory permeameter analyses, 36 core plugs from cores T132 P014 and T104 P014 were analyzed (Appendix 5). Appendix 5 contains the results of conventional statistical analyses of $\mathbf{K_a}$ and porosity values from laboratory analyses and $\mathbf{K_a}$ values from minipermeameter analyses.

Regression analyses comparing the results of the two measurement methods produced an R^2 value of 0.94, a slope of 1.07, and an intercept of –29.5 suggesting that the two measurement techniques yield comparable $\mathbf{K_a}$ values (Figure 5, Appendix 6). In Figure 5, values are scattered almost equally on either side of a regression line plotted diagonally on the graph. This observation suggests that there is no systematic bias imparted to $\mathbf{K_a}$ values obtained using either measurement method (Davis 1986). In the 26 plug samples containing less than 5% cement, the geometric averages of $\mathbf{K_a}$ measurements was 1538 md for laboratory analyses and 1561 md for minipermeameter analyses. The plug samples had an average porosity of 34.1%.

Discussion

With a minimum separation distance of 16 m across the direction of transport (cores along cross-section C-C'), CH intervals can be correlated between wells. The correlations provide a framework within which to analyze lateral variations in lithologic types and permeability values. However, the cores are not spaced closely enough to determine the lateral continuity of many of the *St* sets. The lateral continuity of these *St* sets can be better defined using GPR data to obtain a relatively continuous sampling between cores (Martinez et al. 1998). A study by Martinez (*in prep.*) analyzes vertical profiles of 225-Megahertz (MHz) GPR data that parallel the cross-sections in Plate 1. These GPR

profiles provide the close data spacing that is needed to image the bounding surfaces between these cross-bed sets.

The difficulty in correlating sandstone horizons between wells using only the data obtained from the cores made it necessary to compare the photomosaic (Figure 3) and GPR profiles from Beaty et al. (1997) with cross-sections (Plate 1). By making these comparisons it was possible to correlate intervals between cores and impart the types of geometry observed along the outcrop. An example of the results obtained by such comparison is shown in cross-section C-C' (Plate1). By projecting a northeast-trending profile from the GPR grid, it was possible to identify the location of a large channel discussed in Beaty et al. (1997). A green line on Cross-section C-C' highlights the location of the base of this channel.

The magnitudes of permeability values within adjacent scour-channel fills are ofren different, but the general permeability architecture of the channel fills is similar. The lowest permeability sandstone (50 to 400 md) occurs near the base of channel fills and permeability values generally increase upward. In sandstone samples from the lower flow unit, an inverse relationship was observed between mica content and horizontal $\mathbf{K_a}$ values. Gamma-ray values generally decreased upward within individual *St* sets in the lower flow unit. In the *St* sets containing less than 5% cement, $\mathbf{K_a}$ values generally increase upward. Many of the intervals in the lower flow unit (Plate 1) contain this upward trend in $\mathbf{K_a}$ values. Analyses of petrologic characteristics of *St* sets along the sandstone outcrop and in cores, reveal that lamina from areas near the basal scour surfaces of sets tend to contain more platy mica than lamina higher in the set. The observed upward increase in $\mathbf{K_a}$ values was also observed during a small-scale study of *St* sets discussed in Beaty et al. (*in prep.)*. A few intervals contain several such upward trends in $\mathbf{K_a}$ values as they likely contain several cross-cutting *St* sets.

The cores contain conglomeratic beds that occur at different stratigraphic levels and do not extend between cores. Conglomerate beds at all stratigraphic intervals are similar in composition and tend to contain mostly rounded shale lithoclasts with minor angular limestone fragments. Beds containing thick (greater than 15 cm) shale- and limestone-clast conglomerate are not always present at the base

of the cores (Appendix 1 and Plate 1) suggesting that the conglomeratic interval is sporadic in distribution.

Interpretations

In the lower flow unit, *St* sets generally trend toward the southeast whereas in the upper flow unit, many *St* sets trend toward the southwest, especially near the top of the unit (Beaty et al. 1997). This change in the orientation of *St* sets suggests that the local sediment transport direction changed through time. Near the top of the cored interval, increased gamma ray values are likely due to the increased mica and mud content. Horizontal $\mathbf{K_a}$ values in this interval are lower than the other sandstone intervals (Plate 1). In many of the cores, silty and micaceous plane beds and *Sl* sets from the interval above the upper flow unit contain alternating thick and thin sandstone lamina, suggesting that the sandstone was deposited in an estuary. The presence of mud draped reactivation surfaces and ripple crests in this uppermost interval reinforces the interpretation of an estuarine origin for this uppermost interval.

In the lower flow unit, individual lamina contain quartz sand that is remarkably uniform in grain size but contain differing percentages of mica, depending on position within the *St* set. Observations of sandstone in *St* sets along the outcrop and the upward decrease in gamma ray values in *St* sets in core suggest that during dune migrations within trough scours, finer grained and platy material was concentrated at the toe of foreset beds. The presence of mica causes some basal sandstone lamina to have lower vertical $\mathbf{K_a}$ values, inhibiting hydraulic communication between cross-cutting troughs (Beaty et al., *in prep.*). Values of V:H ratios across these bounding surfaces range from 0.6 to 1.0, with the lowest values near the base of the trough scour and the highest values in lamina at the margins of the trough scour (Beaty et al., *in prep.*). Along the outcrop, bounding surfaces between lamina at the margins of scour-channel fills are commonly barely perceptible. Thus, lamina boundaries in these marginal areas of the trough would likely be negligible barriers to fluid flow. Conversely, because of their lower V:H ratios, the presence of micaceous sandstone lamina at the bases of trough scours may

have a more marked effect on fluid flow (Beaty et al., *in prep.*). Micaceous sandstone lamina at the bases of trough scours account for only a small percentage of the volume of sandstone, but they are one of the most important controls on the permeability architecture of systems containing fluvial *St* sets (Weber 1982).

Mica content was not the only factor that influenced the magnitude of horizontal $\mathbf{K_a}$ values. Magnitudes of horizontal $\mathbf{K_a}$ values were also influenced by other parameters such as the grain size, the degree of sorting, and the amount of iron oxide or hydroxide cement present. Beard and Weyl (1973) suggest that grain size and sorting are the two most important controls on the permeability values of sandstone. Minipermeameter and laboratory permeameter measurements of $\mathbf{K_a}$ values in sandstone containing thick sandy lamina with little mica are similar to permeability values measured for wet-packed sandstone with similar grain sizes and degrees of sorting (Beard and Weyl 1973). In samples with relatively little cement, micaceous lamina boundaries are the most likely cause of dissimilarities between Tonganoxie Sandstone and Beard and Weyl (1973) values. Thin section analyses reveal that samples containing >4% mica generally have significantly lower horizontal $\mathbf{K_a}$ values than samples containing thick sandy lamina with little mica, even when they contain quartz sand with similar grain size and sorting (Appendix 4).

In incised valley-fills, conglomerate is generally thought to develop in fluvial valleys as a lag deposit on the sequence boundary during eustatic lowstand (Zaitlin et al. 1994) or as a lag deposit along ravinement surfaces during transgression (Van Wagoner 1990). The basal interval in most of the cores did not contain as much conglomeratic material as the beds in the conglomerate outcrop (p. 3) across the road from the sandstone outcrop. Observing the thickness and extent of conglomerate and conglomeratic sandstone beds only along the outcrop could easily cause the investigator to infer that they are of significant lateral extent. However, it was not possible to correlate even the thicker conglomeratic beds between closely spaced core holes. The presence of conglomeratic sandstone beds that occur sporadically, at higher levels in the cores suggests that clast developments were not limited to lag deposits associated with unique chronostratigraphic surfaces. Such rapid changes suggest that

autogenic processes may be responsible for distributing the conglomeratic material. The conglomerate clasts may have come from nearby tributary valleys during times of downcutting and headward erosion (Beaty, *in prep.*).

The observation that conductivity logs responded to changes in mica content is important for interpretation of ground-penetrating radar (GPR) data. The micaceous surfaces have increased conductivity resulting in attenuation of radar signals. As a result, these micaceous surfaces usually are good electromagnetic reflectors. Caution must be used when interpreting conductivity logs in wells without cores, however, because not all such perturbations are related to changes in mica content. Conductivity values can also increase in the presence of iron oxide and hydroxide cements. Fe oxide and hydroxide cements are highly conductive and absorb much of the GPR signal, causing attenuation.

Conclusions

At the fluvial study site, studies of cross-cutting *St* sandstone sets along the outcrop face yielded two-dimensional information concerning the variability of lithologic types and distribution of $\mathbf{K}_a$ values, but revealed little concerning their three-dimensional variability. Closely spaced cores from behind the outcrop face allowed the distribution of lithologic types to be studied in three dimensions and allowed laboratory analyses of $\mathbf{K}_a$, porosity, and grain density.

By comparing the cross-sections with the photomosaic and GPR profiles, it was possible to incorporate realistic geometric information to all CH intervals and correlate intervals with disparate well log and core information. In many cases, CH intervals were correlative across entire core cross-sections. Although it was not possible to correlate many of the individual *St* sets between cores, the cores provided very important information concerning vertical variations in lithologic types, permeability values, and well log response through the sets.

The magnitudes of the $\mathbf{K}_a$ values between vertically adjacent sets are commonly different, but the general $\mathbf{K}_a$ architecture of the *St* sets are very similar. In cores and in outcrop, an inverse relationship was observed between mica content and horizontal $\mathbf{K}_a$ values. Along individual lamina, quartz sand

was remarkably uniform in grain size. In vertical profile, lamina contained differing percentages of mica, depending on position within the *St* set. Platy material was concentrated at the toe of foreset beds during dune migrations within trough scours. The presence of greater percentages of mica in the lowest portions of trough scours may inhibit hydraulic communication between *St* sets in these areas.

Conglomeratic intervals in cores were not as well developed as those observed across the road from the fluvial outcrop site of Beaty et al. (1997and conglomeratic sandstone also occurs at higher intervals in many of the cores. These findings suggest that autogenic processes dominated the deposition of the conglomerate beds. The conglomeratic intervals are not exclusively lag deposits associated with unique chronostratigraphic surfaces related to different phases of relative sea level change.

Permeability values measured with the minipermeameter and lab permeameter yielded comparable results. A statistical comparison of $\mathbf{K_a}$ measurements found that no significant difference exists between the values obtained using the two techniques.

Wireline logs were used to analyze the causes of reflections and signal attenuation in GPR data obtained from the field. Micaceous lamina surfaces cause minor increases in conductivity and, thus, act as electromagnetic reflectors. Conversely, iron oxide cements are highly conductive and absorb much of the GPR signal causing attenuation.

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References

Archer, A. W., H. R. Feldman, and W. P. Lanier, 1993, Road log and field guide, *in* A. W. Archer, H. R. Feldman, and W. P. Lanier, eds., Incised paleovalleys of the Douglas Group in northeastern Kansas: field guide and related contributions, Kansas Geological Survey Open-File Report 93-24, Stop 1-3.

Archer, A. P., W. P. Lanier, and H. R. Feldman, 1994, Stratigraphy and depositional history within incised-paleovalley fills and related facies, Douglas Group (Missourian/Virgilian; Upper Carboniferous) of Kansas, U. S. A., *in* R. W. Dalrymple, R. Boyd, and B. A. Zaitlin, eds., Incised Valley Systems: Origin and Sedimentary Sequences: SEPM (Society for Sedimentary Geology) Special Publication No. 51, p. 175-190.

Beard and Weyl, 1973, Influence of texture on porosity and permeability of unconsolidated sand: American Association of Petroleum Geologists Bulletin, V. 57, No. 2, pp. 349-369.

Beaty, D. S., *in prep.*, Stratigraphic influences on the permeability architecture of fluvial and estuarine sandstones in the Tonganoxie incised valley-fill of northeast Kansas, USA. Ph.D. dissertation, University of Kansas.

Beaty, D. S., A. Martinez, and A. Byrnes, *in prep.*, Permeability structure and fluid-flow characteristics of fluvial trough cross-beds, Tonganoxie sandstone, northeast Kansas: SPE Formation Evaluation.

Beaty, D. S., A. Martinez, and A. W. Walton, 1997, Combined minipermeameter and ground-penetrating radar characterization of Tonganoxie valley-fill sandstones, Upper Pennsylvanian, northeastern Kansas, *in* Shallow Marine and Nonmarine Reservoirs; Sequence Stratigraphy, Reservoir Architecture, and Production Characteristics. Proceedings of the Gulf Coast Section Society of Economic Paleontologists and Mineralogists, 18th Annual Research Conference, Houston, Texas, December 1997, p. 47-63.

Davis, J. C., 1986, Statistics and Data Analysis in Geology: John Wiley and Sons, New York, 646 p.

Feldman, H. R., M. R. Gibling, A. W. Archer, W. G. Wightman, and W. P. Lanier, 1995, Stratigraphic architecture of the Tonganoxie paleovalley fill (Lower Virgilian) in Northeastern Kansas: AAPG Bulletin, v. 79, p. 1019-1042.

Martinez, A., *in prep.*, Ground-penetrating radar in sedimentary rocks of northeast Kansas, USA. Ph.D. dissertation, University of Kansas.

Martinez, A., and D. S. Beaty, *in review*, Stratigraphic imaging capabilities of ground-penetrating radar in a fluvial sandstone: Geophysics.

Martinez, A., E. K. Franseen, and D. S. Beaty 1998. Applications of ground-penetrating radar to sedimentologic and stratigraphic studies - examples from Pennsylvanian siliciclastics and carbonates in Kansas: GPR 98 conference expanded abstract, 6 p.

Miall, A. D., 1985, Architectural-element analysis: a new method of facies analysis applied to fluvial deposits: Earth Science Reviews, v. 22, p. 261-308.

Minor, J. A., 1969, Petrology of the Tonganoxie Sandstone (Pennsylvanian), Kansas-Missouri: MS thesis, University of Missouri, Columbia, Missouri, 98 p.

O'Conner, H. G., 1960. Geology and ground water resources of Douglas County, Kansas: Kansas Geological Survey Bulletin 148, 200 pp.

Weber, K. J., 1982, Influence of common sedimentary structures on fluid flow in reservoir models: Journal of Petroleum Technology, V. 34, No. 3, p. 665-672.

Williams, H., F. J. Turner, and C. M. Gilbert, 1982, Petrography: an introduction to the study of rocks in thin sections; second edition. W. H. Freeman and Company, New York, 626 pp.

Zaitlin, B. A., R. W. Dalrymple, and R. Boyd, 1994, The stratigraphic organization of incised-valley systems associated with relative sea-level change, *in* R. W. Dalrymple, R. Boyd, and B. A. Zaitlin, eds., Incised valley systems: origin and sedimentary sequences: SEPM Special Publication 51, p. 45-60.

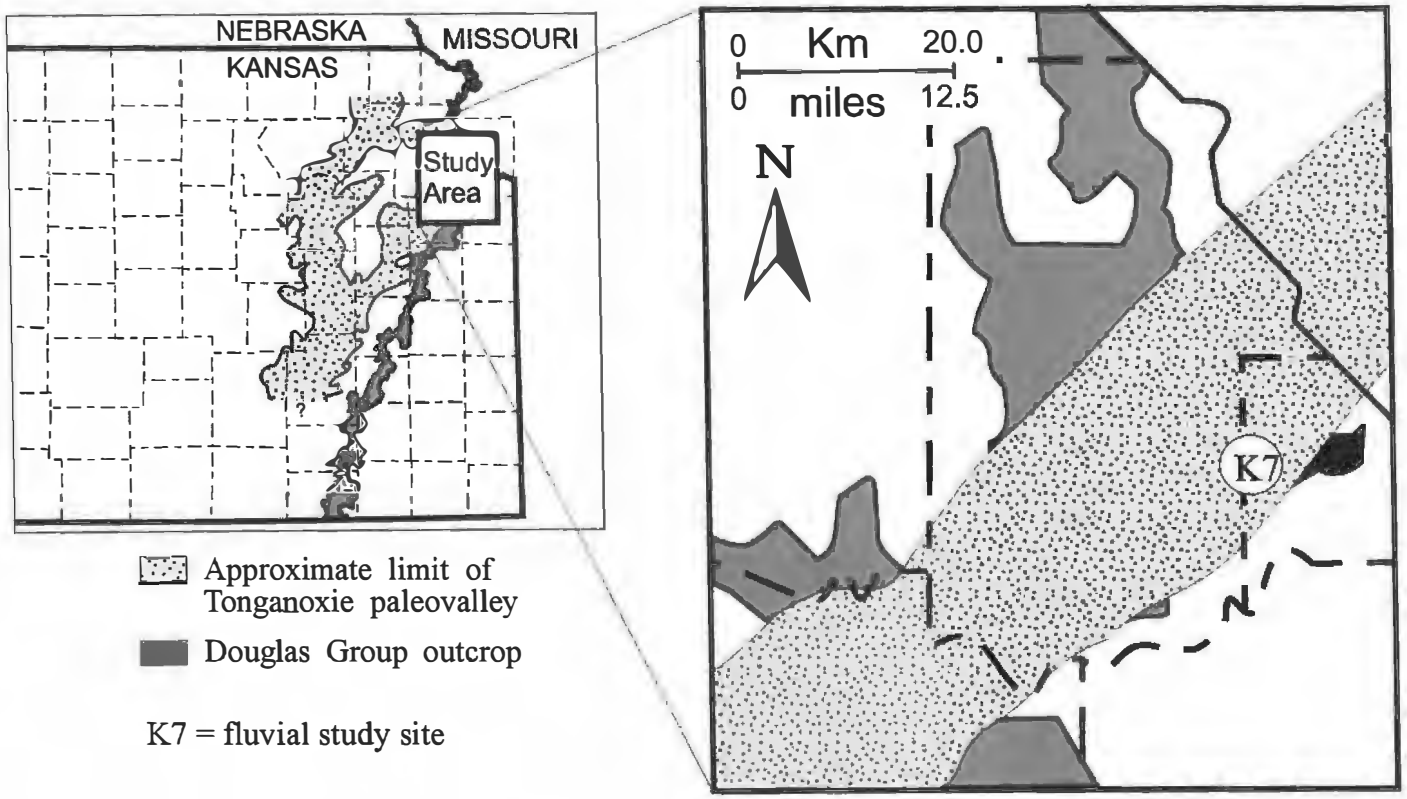


Figure 1 - Maps showing the location of the fluvial study site in northeast Kansas in relation to the limits of the Tonganoxie Paleovalley and the outcrop belt. Modified from Feldman et al. (1995).

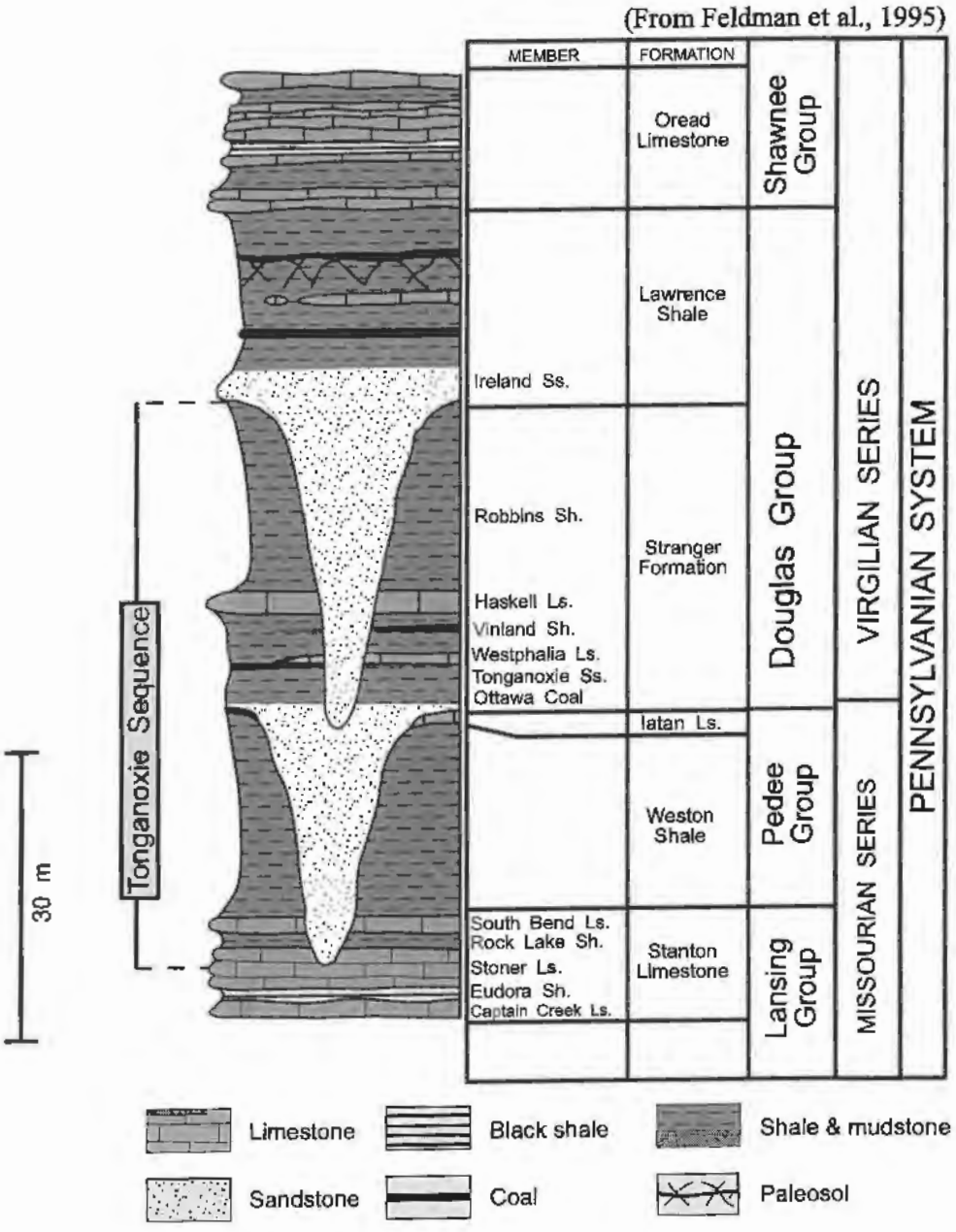


Figure 2 - Stratigraphic chart showing the placement of the Tonganoxie IVF in the Pennsylvanian System. The lower and upper boundaries of the Tonganoxie Sequence (Archer et al. 1994) are shown on the left side of the diagram. Modified from Feldman et al. (1995).

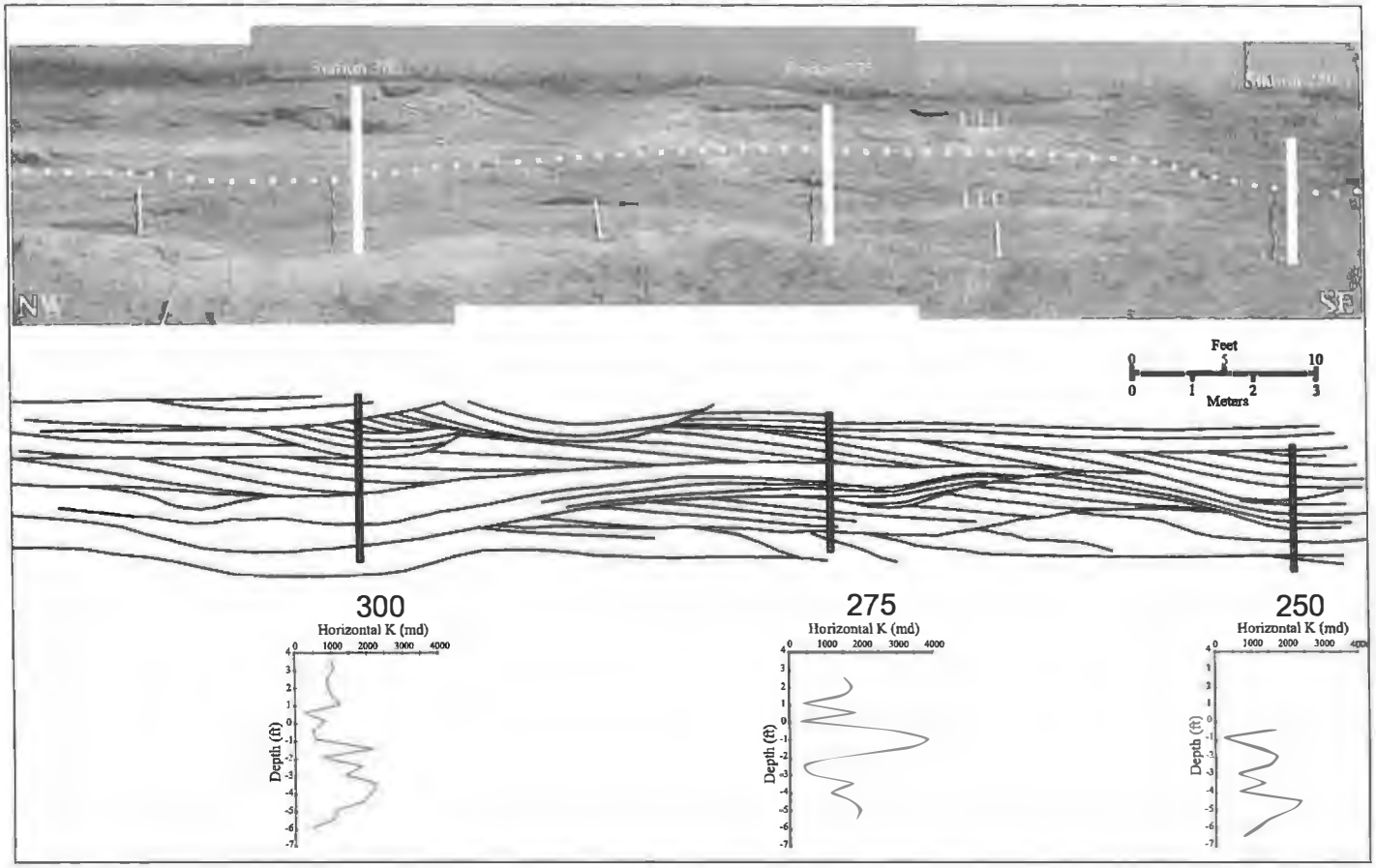


Figure 3 - Photomosaic showing a 25 m (82 ft) long segment of the outcrop at the Highway 7 Fluvial Study site in Wyandotte County, Kansas. The vertical white lines on the photomosaic show the locations of the horizontal K profiles at the bottom of the diagram. The dashed white line shows the approximate location of the boundary between the upper flow unit (UFU) and the lower flow unit (LFU).

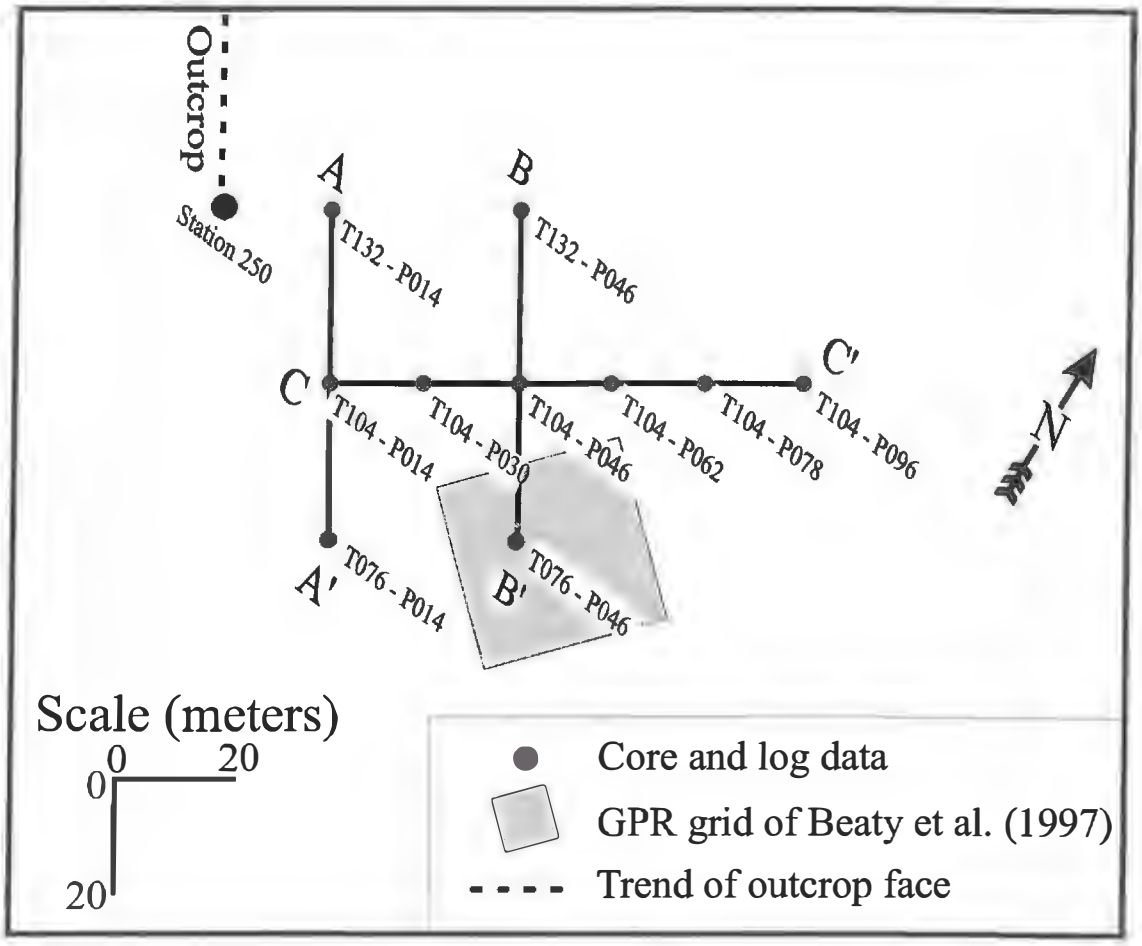


Figure 4 - Location of cores examined in this study. 10 cores were drilled in the field behind the fluvial outcrop site of Beaty et al. (1997). Six of the cores were drilled 16 meters apart in a northeast-trending transect and four were drilled 28 meters away from the transect. Core T132 P014 was drilled approximately 18 meters from the outcrop face, northeast of station 250.

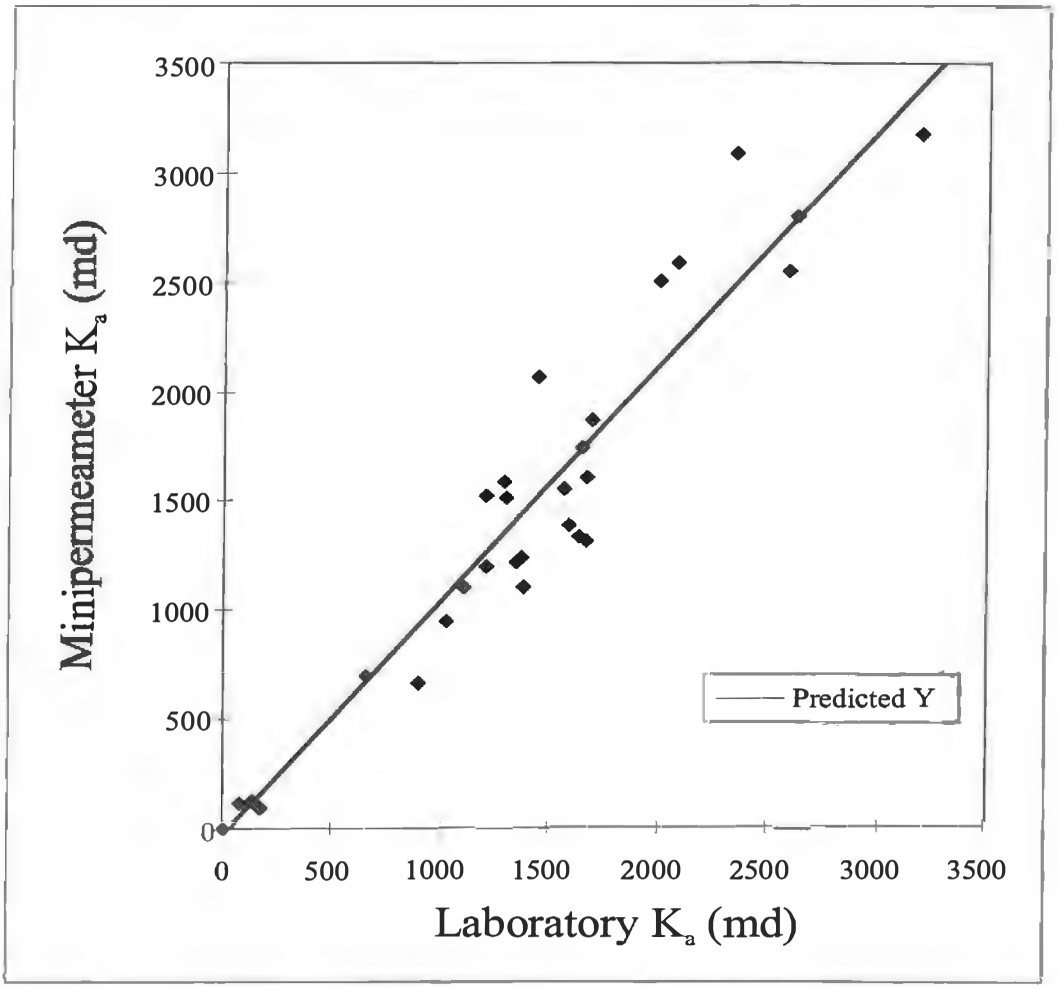
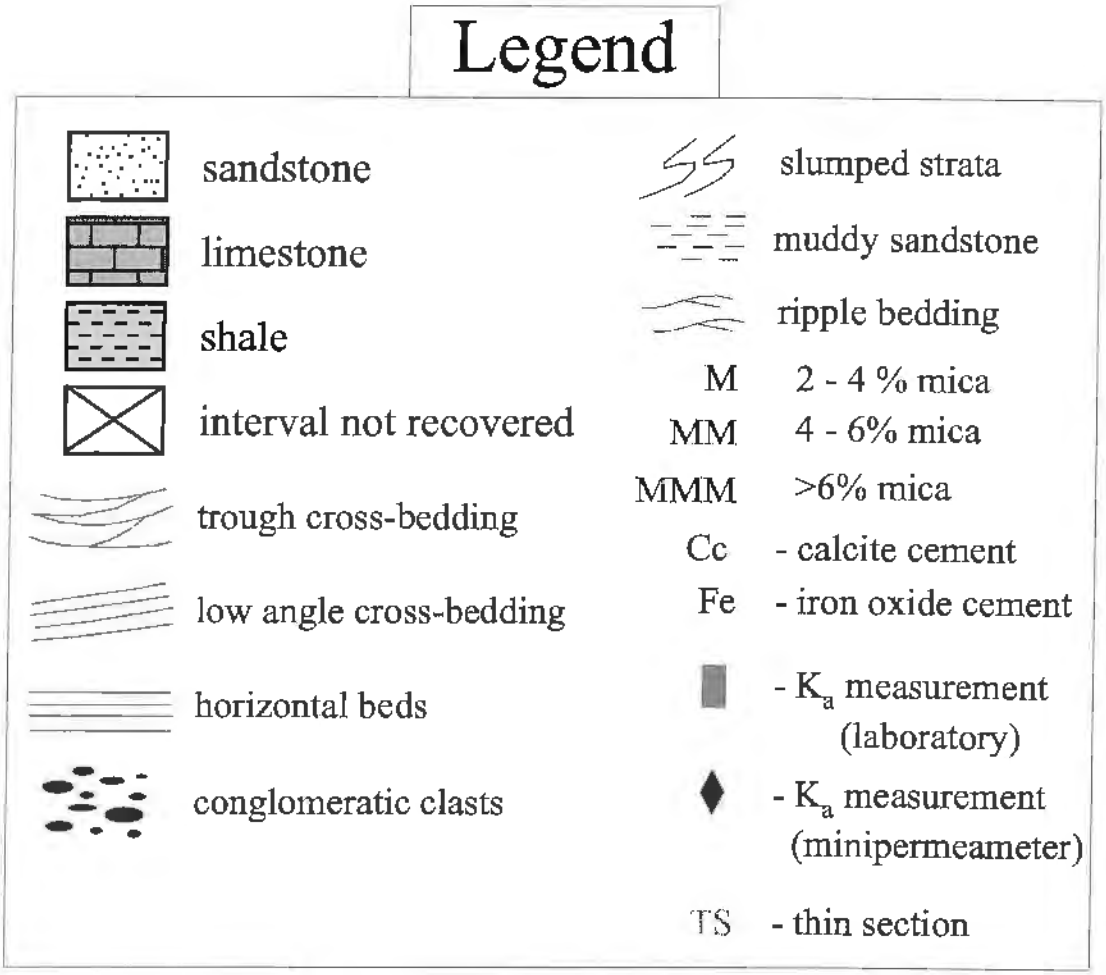
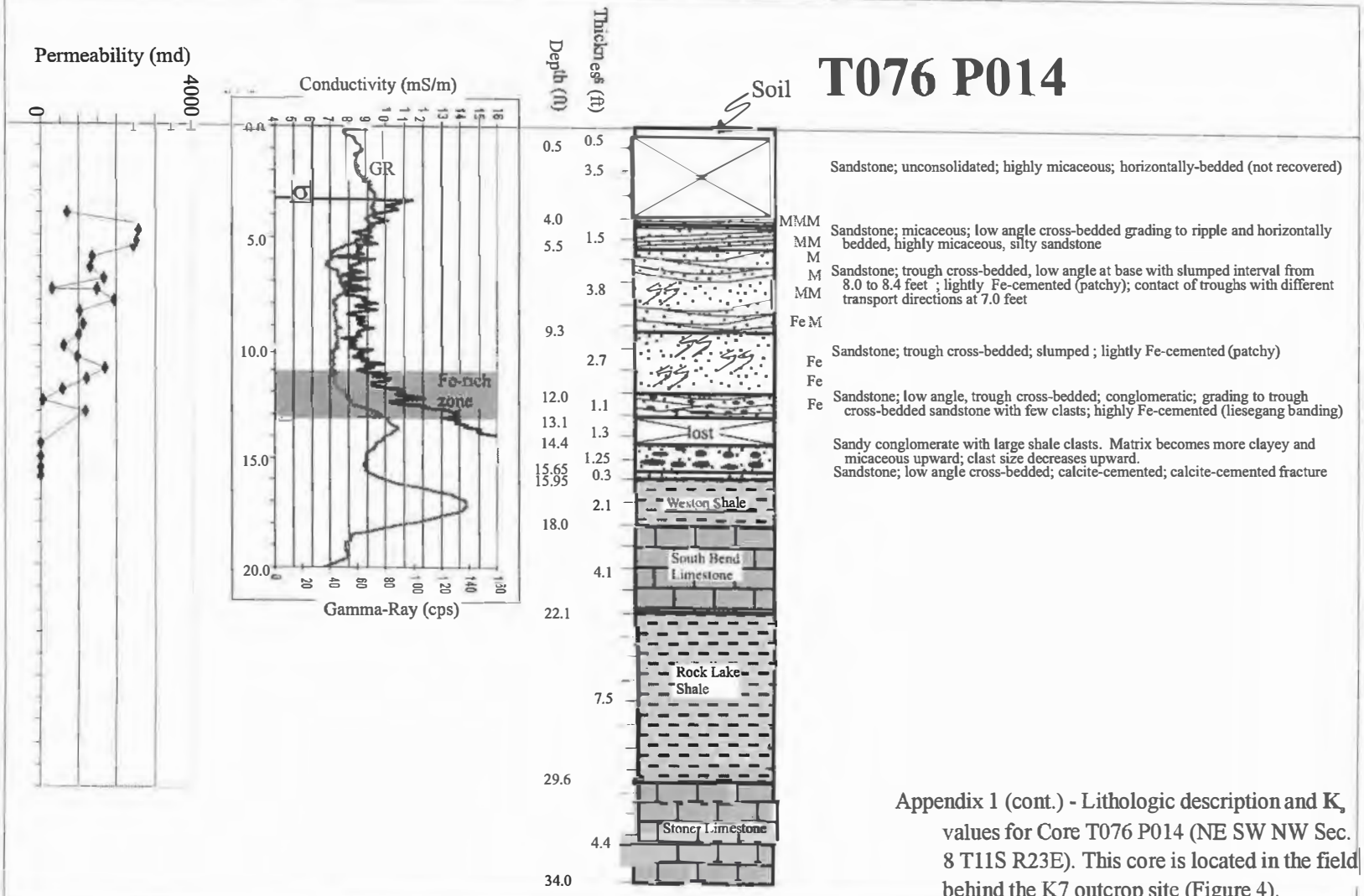


Figure 5 - Comparison of minipermeameter and laboratory air permeability (K_a) values for 36 plugs from cores T104 P014 and T132 P014.

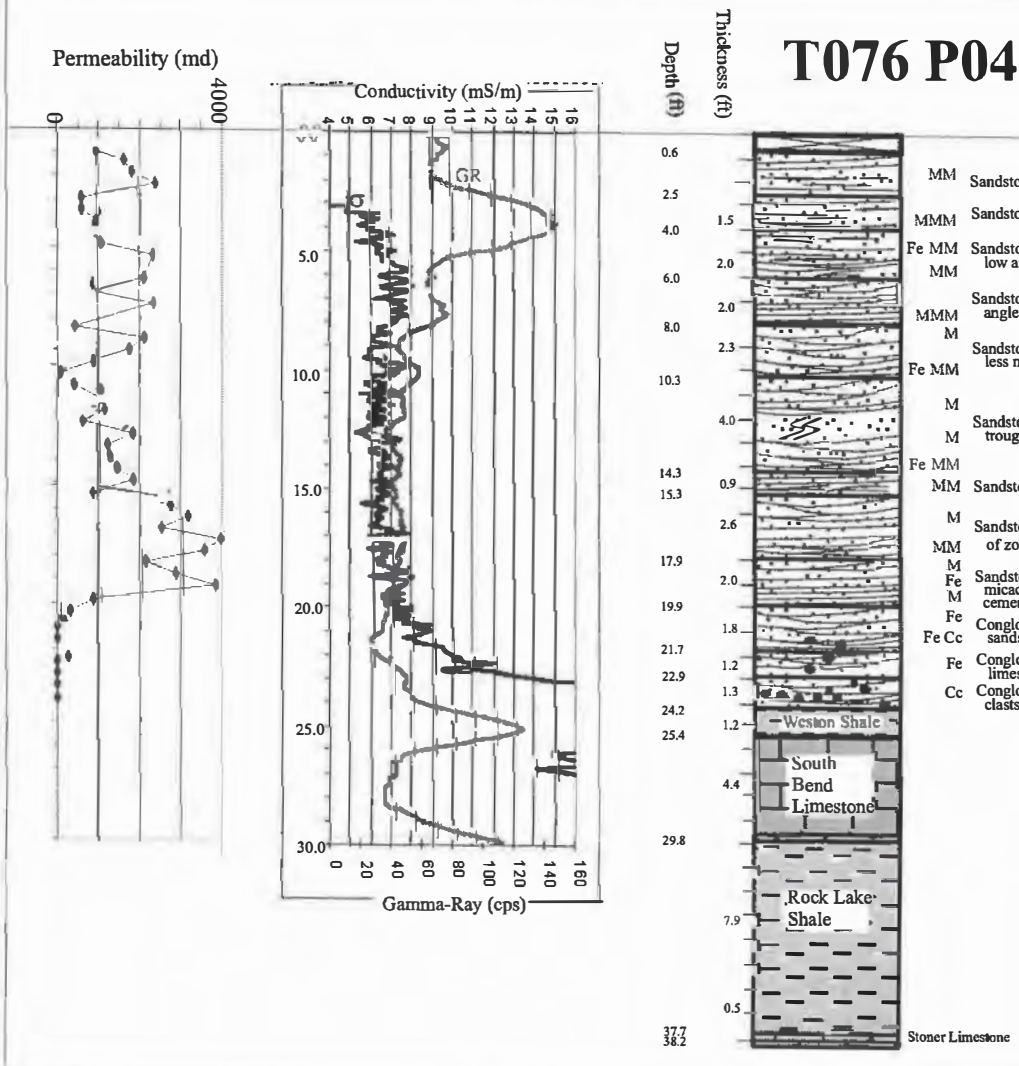


Appendix 1 - Legend for descriptions of 10 cores from Wyandotte County, NE SW NW Section 8, Township 11 South, Range 23 East.



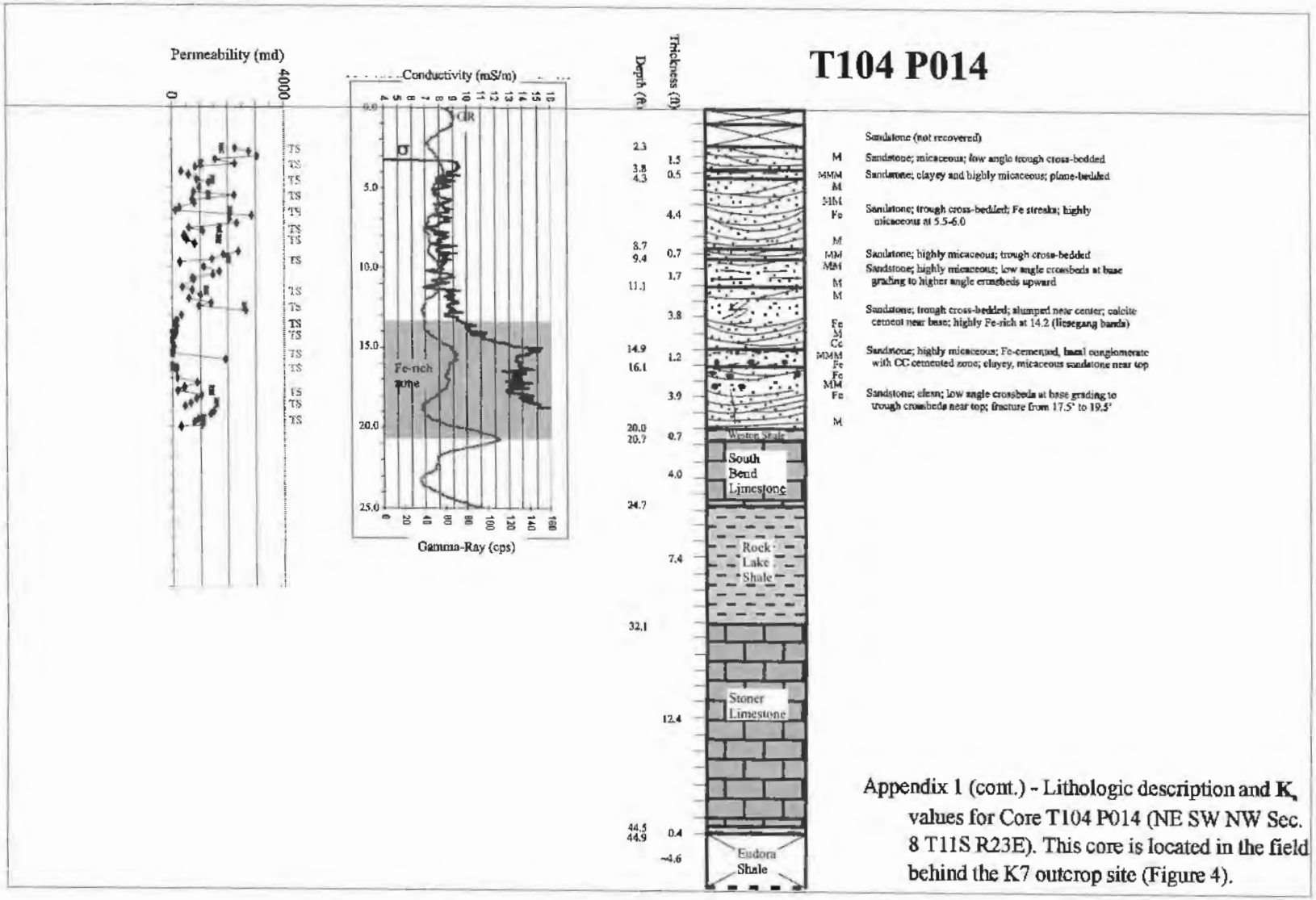
Appendix 1 (cont.) - Lithologic description and K_a values for Core T076 P014 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).

T076 P046

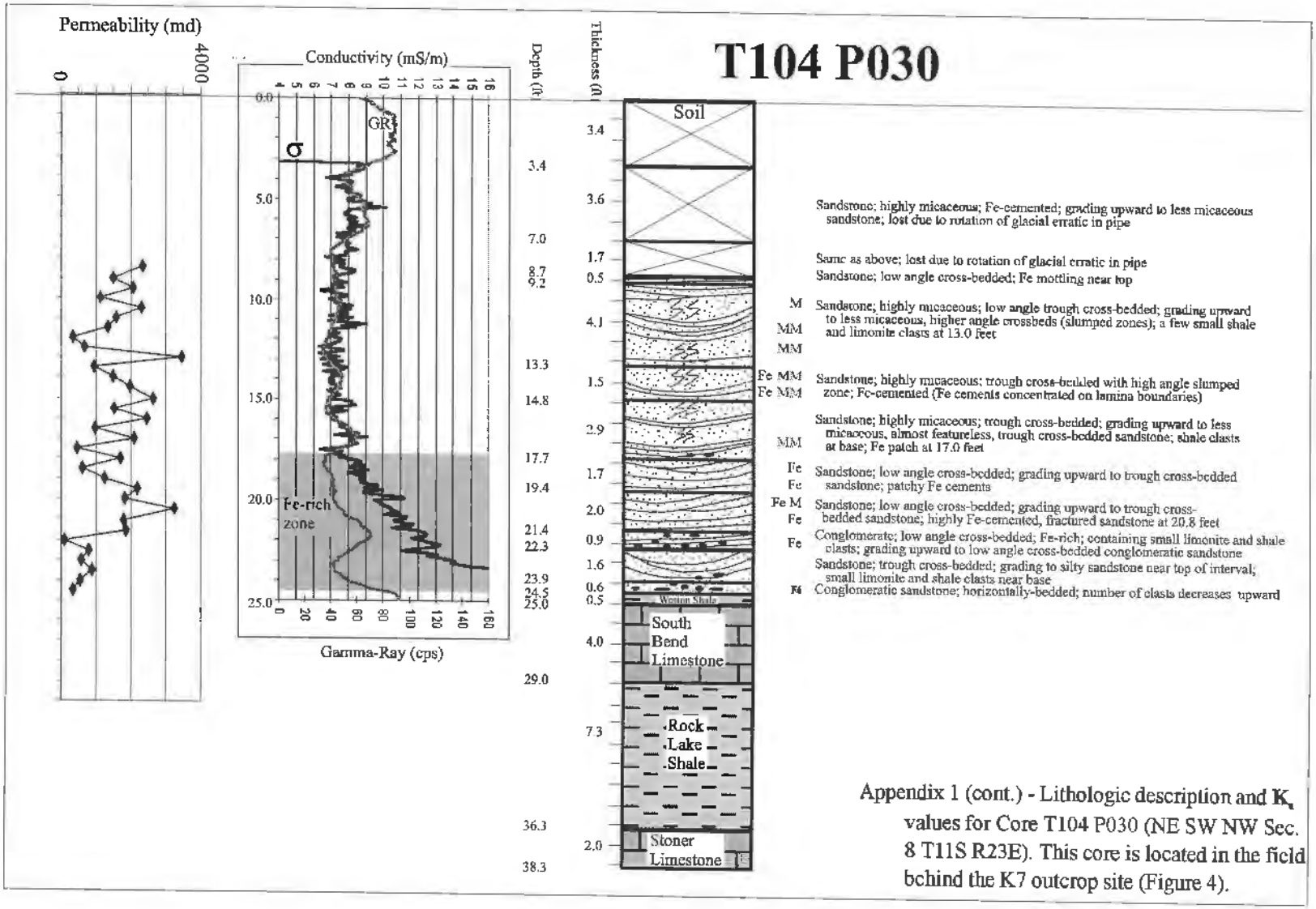


MM	Sandstone; horizontally bedded; silty and micaceous; low angle crossbeds near top
MMM	Sandstone; silty and shaly; very low angle crossbeds; horizontal lamina (tidal bundling?)
Fe MM	Sandstone; soft, shaly and micaceous; ripple-bedded near base; grading upward to harder, very low angle cross-bedded or horizontally laminated sandstone
MM	
MMM	Sandstone; silty and micaceous; low angle, very thinly cross-bedded; grading upward to higher angle, small-scale, less micaceous, trough cross-bedded sandstone
M	
Fe MM	Sandstone; micaceous; low angle trough cross-bedded, grading upward to higher angle, less micaceous, trough cross-bedded sandstone
M	
M	Sandstone; micaceous; low angle trough cross-bedded; grading upward to higher angle trough crossbedded sandstone; wood fragments at 11.7 feet; slumped from 11.8 to 13.1 feet
Fe MM	
MM	Sandstone; soft; silty; ripple bedded; grading upward to low angle crossbeds
M	Sandstone; micaceous, trough cross bedded at base; grading to low angle cross-beds in center of zone; less micaceous trough cross-bedded sandstone above 16.8'
MM	
M	
Fe	Sandstone; micaceous; low angle cross-bedded; grading upward to higher angle, less micaceous, trough cross-bedded sandstone; wood fragments; Fe concretions; streaks of CC cement
M	
Fe	Conglomeratic sandstone; Cc-cemented; grading upward to trough cross-bedded, Fe-cemented sandstone (liesegang banding); limestone and shale clasts; fracture from 19.8 to 20.9 feet
Fe Cc	
Fe	Conglomeratic sandstone; trough cross-bedded; Fe cement; pressed wood fragments; limestone and shale clasts increase in abundance near top
Cc	Conglomerate; sandy; trough cross-bedded; highly cemented with CC; limestone and shale clasts

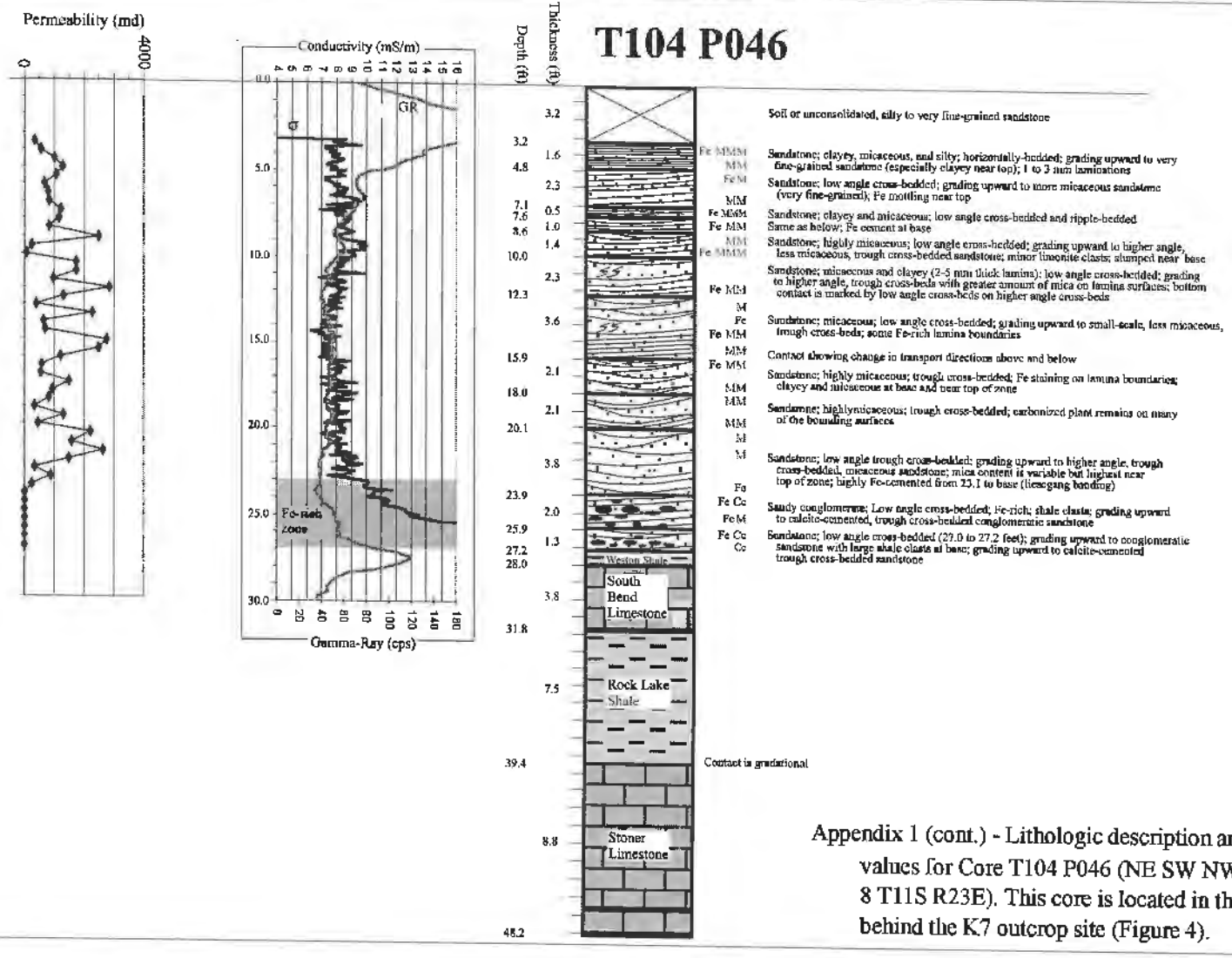
Appendix 1 (cont.) - Lithologic description and K_a values for Core T076 P046 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



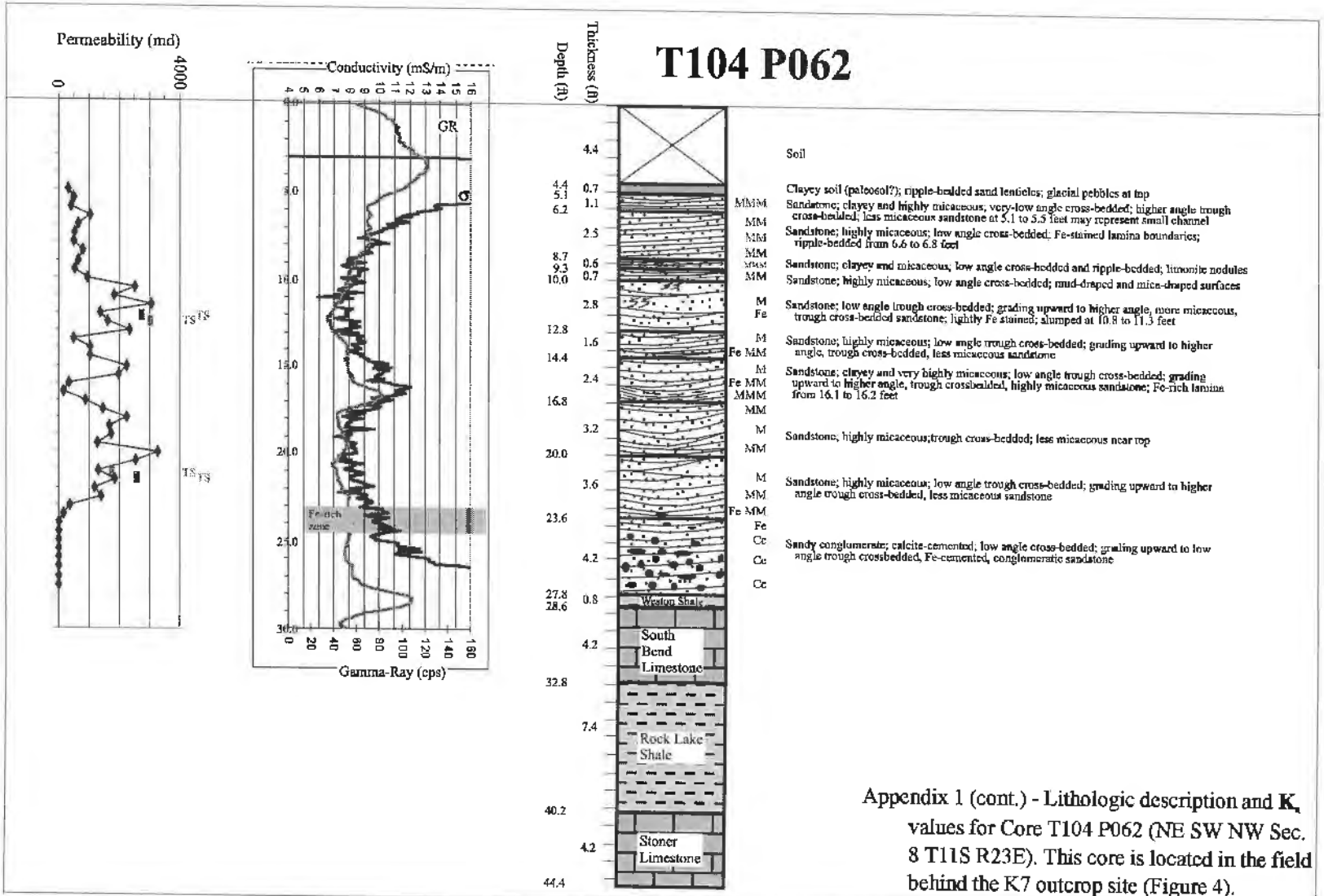
Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P014 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



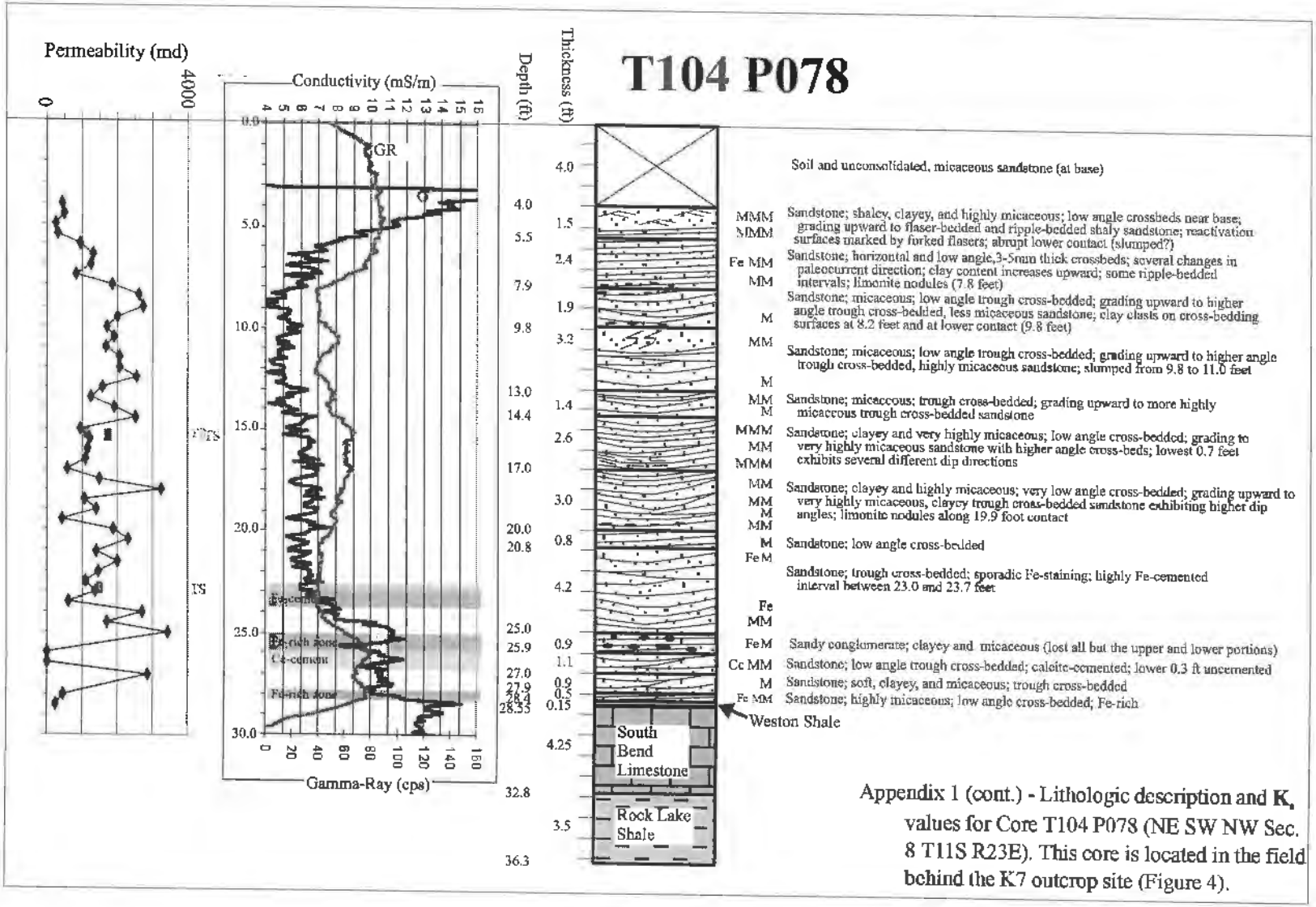
Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P030 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



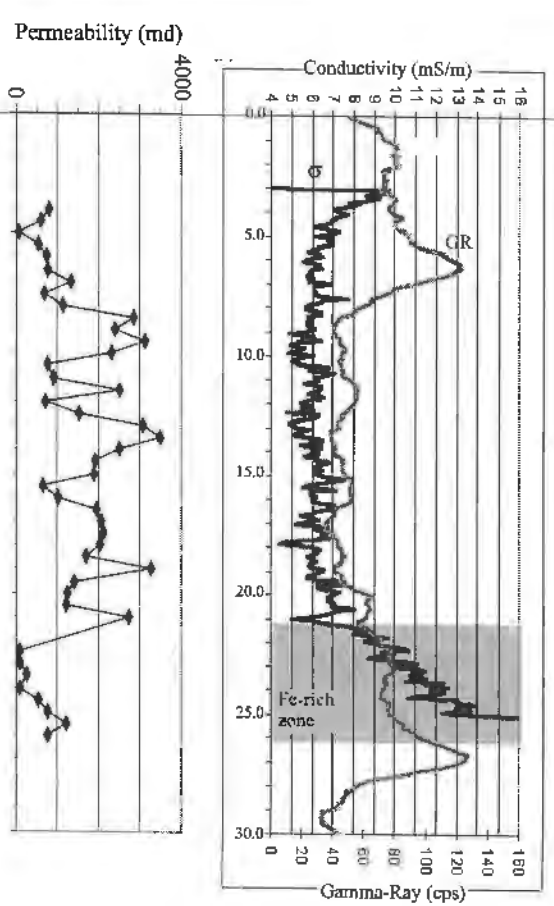
Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P046 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



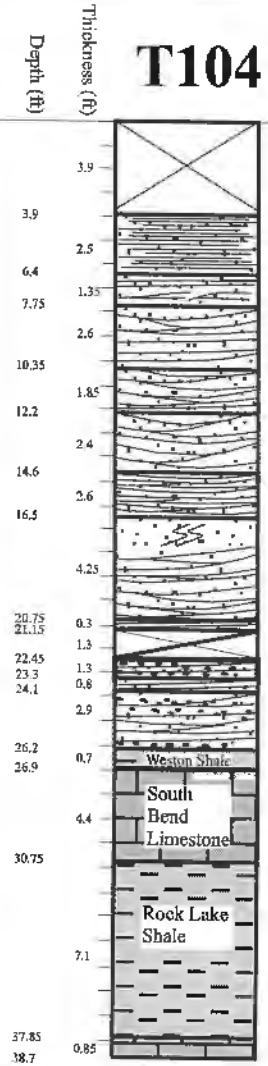
Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P062 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P078 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



T104 P094



MM
MM Sandstone; silty to very fine grained; clayey and micaceous; low angle cross-beds
MMM near base grading upward to horizontal bedding with low angle crossbeds near top;
MMM some indications of tidal bundling
MM Sandstone; very fine grained; shaly and micaceous; ripple-bedded (6.4 to 7.75 feet)
MM grading upward to very low angle cross-bedded or horizontally laminated sandstone

Sandstone; very fine to fine grained; trough cross-bedded; micaceous and silty near base
M grading upward to less micaceous sandstone

M Sandstone; very fine to fine grained; micaceous, low angle thinly trough cross-bedded
MM grading upward to higher angle, less micaceous, trough crossbedded sandstone; 1 to 3 mm clasts at base

M Sandstone; very fine to fine grained; Fe mottled low angle trough cross-bedded at base
Fe grading upward to higher angle, trough cross-bedded sandstone with less Fe staining
M
MM Sandstone; very fine to fine grained; micaceous; finely laminated, trough cross-bedded
M

M Sandstone; very fine to fine grained; micaceous low angle trough cross-bedded grading upward to higher angle, less micaceous, trough cross-bedded sandstone; convoluted near top

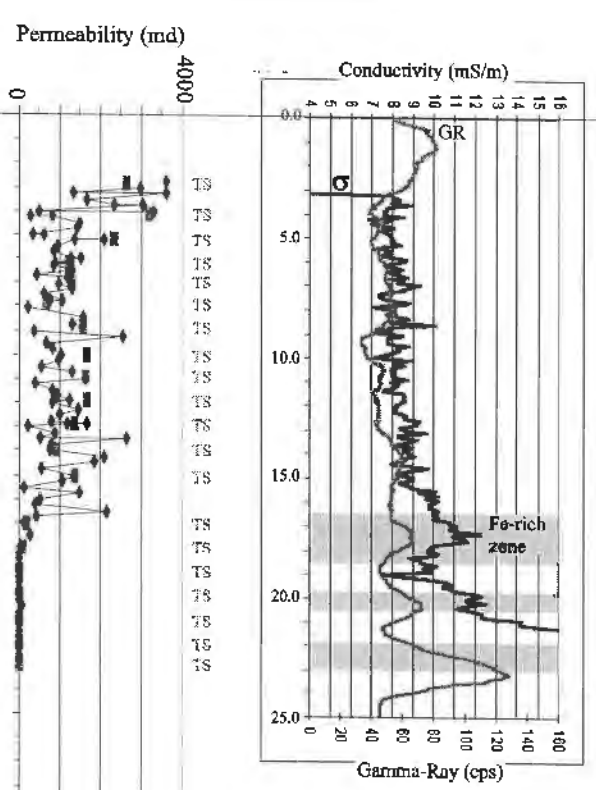
MM
Fe Sandstone; very fine to fine grained; silty and micaceous; low angle crossbeds

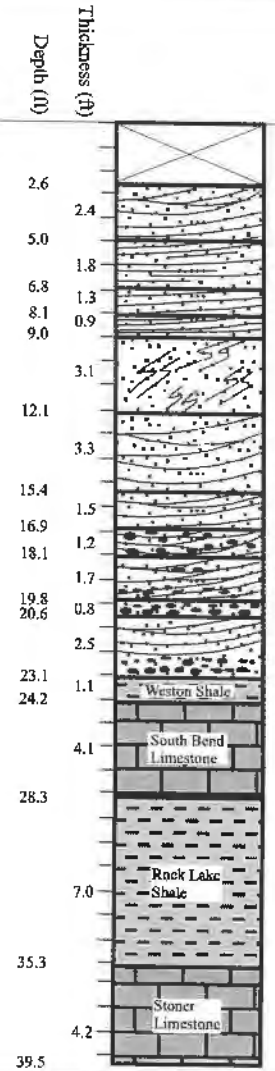
Missing 1.3 ft of Fe cemented conglomerate

Fe Conglomeratic sandstone; Fe-cemented (liesegang banding); clasts are mainly shale
Sandstone; very fine to fine grained; micaceous and clayey; low angle crossbeds;
Fe 0.05 foot shale bed at base
Sandstone; very fine to fine grained; silty and micaceous; low angle crossbeds grading
Fe upward to higher angle trough crossbeds; 0.05 foot Fe cemented conglomerate at base and small shale clasts (1-4 mm) in interval from 24.1 to 24.8

Appendix 1 (cont.) - Lithologic description and K_v values for Core T104 P094 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).

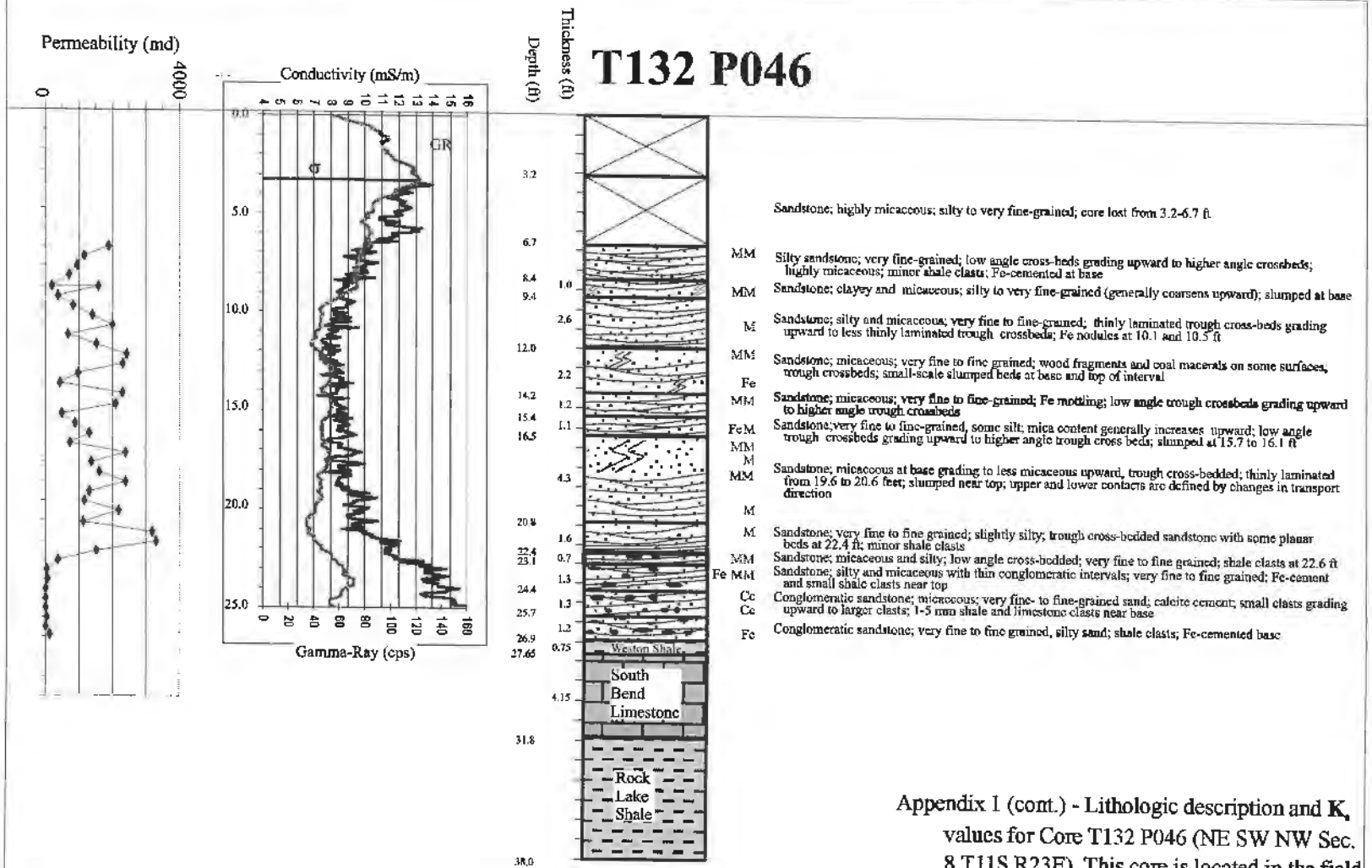
T132 P014





MM	Sandstone; trough cross-bedded; Fe cement in some portions
M	
MM	Sandstone; highly micaceous; low angle cross-bedded; poorly indurated near center of zone
MM	
M	Sandstone; low angle cross-bedded
MM	Sandstone; highly micaceous; low angle cross-bedded; Fe-cemented at upper contact
	Sandstone; highly convoluted trough cross-bedded
M	
M	Sandstone; trough cross-bedded; coal macerals and mica on cross-bed surfaces
M	
MM	Sandstone; highly micaceous; trough cross-bedded
M	
Fe MM	Conglomeratic sandstone; micaceous; trough cross-bedded; cemented with
Fe M	hydrous Fe-oxide; shale clasts increase in size and number upward
MMM	Sandstone; highly micaceous; trough cross-bedded calcite cemented at base;
Cc	with minor shale clasts near top
Fe	Conglomeratic sandstone; clasts decreasing in size upward
M	Sandstone; trough cross-bedded; conglomeratic at base;
Cc	calcite cement; Fe-cemented from 21.0' to 22.1'

Appendix 1 (cont.) - Lithologic description and K_a values for Core T132 P014 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).



Appendix 1 (cont.) - Lithologic description and K_v values for Core T132 P046 (NE SW NW Sec. 8 T11S R23E). This core is located in the field behind the K7 outcrop site (Figure 4).

Appendix 2 - Minipermeameter data and Ka values from analyses of cores from the field behind the fluvial outcrop site

Minipermeameter Data from core T076 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T076 P014	H	4.00	13.99	19.80	859.38	87.8	5.1	0.062	0.125	**701.0**	
T076 P014	H	4.50	13.99	15.82	879.40	88.6	5.1	0.062	0.125	**2580.5**	suspect measurement
T076 P014	H	5.00	13.99	15.87	888.18	88.8	5.1	0.062	0.125	**2534.6**	
T076 P014	H	5.50	13.99	15.96	896.48	88.9	5.1	0.062	0.125	**2440.1**	
T076 P014	H	6.00	13.99	17.48	926.27	89.0	5.1	0.062	0.125	**1350.5**	
T076 P014	H	6.50	13.99	17.66	929.20	89.2	5.1	0.062	0.125	**1279.8**	
T076 P014	H	7.00	13.99	16.93	936.04	89.4	5.1	0.062	0.125	**1648.4**	
T076 P014	H	7.45	13.99	26.04	906.25	89.3	5.1	0.062	0.125	**301.0**	
T076 P014	H	7.50	13.99	17.32	955.57	89.6	5.1	0.062	0.125	**1467.1**	
T076 P014	H	8.00	13.99	16.60	957.52	89.9	5.1	0.062	0.125	**1919.7**	Fe mottled
T076 P014	H	8.50	13.99	18.64	974.12	90.1	5.1	0.062	0.125	**1028.4**	Fe mottled
T076 P014	H	9.00	13.99	18.36	974.12	90.3	5.1	0.062	0.125	**1104.1**	Fe mottled
T076 P014	H	9.50	13.99	18.75	979.98	90.7	5.1	0.062	0.125	**1007.5**	Fe mottled
T076 P014	H	10.00	13.99	21.50	993.65	91.1	5.1	0.062	0.125	**597.7**	Fe cemented
T076 P014	H	10.50	13.99	19.07	1000.49	91.4	5.1	0.062	0.125	**955.1**	Fe cemented
T076 P014	H	11.00	13.99	17.14	1022.46	91.1	5.1	0.062	0.125	**1671.3**	Fe cemented
T076 P014	H	11.50	13.99	18.25	1026.86	91.0	5.1	0.062	0.125	**1198.1**	Fe mottled
T076 P014	H	12.00	13.99	22.24	1038.57	90.9	5.1	0.062	0.125	**556.7**	Fe cemented
T076 P014	H	12.50	13.99	34.57	385.99	91.2	5.1	0.062	0.125	**61.9**	Highly Fe cemented
T076 P014	H	13.00	13.99	18.43	1060.06	90.8	5.1	0.062	0.125	**1179.1**	Fe cemented conglomerate
T076 P014	H	14.50	13.99	39.04	2.92	91.1	5.1	0.062	0.125	**0.4**	Cc cemented conglomerate
T076 P014	H	15.00	13.99	39.06	2.63	91.2	5.1	0.062	0.125	**0.3**	Cc cemented conglomerate
T076 P014	H	15.50	13.99	38.21	5.57	91.2	5.1	0.062	0.125	**0.7**	Cc cemented conglomerate
T076 P014	H	15.90	13.99	38.49	4.25	91.2	5.1	0.062	0.125	**0.5**	Cc cemented sandstone

Appendix 2 (cont.)

Minipermeameter Data from core T076 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T076 P046	H	0.60	14.04	18.82	961.43	80.6	5.1	0.062	0.125	**977.5**	
T076 P046	H	1.00	14.04	17.04	973.63	81.4	5.1	0.062	0.125	**1668.3**	
T076 P046	H	1.50	14.04	16.80	981.45	82.0	5.1	0.062	0.125	**1845.3**	
T076 P046	H	2.00	14.04	16.20	994.14	82.3	5.1	0.062	0.125	**2433.9**	Fe mottled
T076 P046	H	2.50	14.04	21.41	1000.98	82.4	5.1	0.062	0.125	**612.6**	micaceous
T076 P046	H	3.00	14.04	21.45	1001.95	83.1	5.1	0.062	0.125	**609.6**	micaceous
T076 P046	H	3.50	14.04	19.06	1010.25	83.9	5.1	0.062	0.125	**973.6**	micaceous
T076 P046	H	4.00	14.04	19.34	1017.09	84.3	5.1	0.062	0.125	**920.5**	micaceous
T076 P046	H	4.50	14.04	18.77	1026.86	84.9	5.1	0.062	0.125	**1057.5**	micaceous; Fe mottled
T076 P046	H	5.00	14.04	16.37	1035.16	85.5	5.1	0.062	0.125	**2337.1**	micaceous
T076 P046	H	6.00	14.04	16.64	1049.32	85.9	5.1	0.062	0.125	**2106.0**	micaceous
T076 P046	H	6.50	14.04	19.78	1056.64	86.4	5.1	0.062	0.125	**872.0**	
T076 P046	H	7.00	14.04	16.43	1066.90	87.0	5.1	0.062	0.125	**2343.4**	
T076 P046	H	8.00	14.04	24.50	1080.57	87.2	5.1	0.062	0.125	**429.2**	
T076 P046	H	8.50	14.04	16.74	1090.82	87.1	5.1	0.062	0.125	**2103.8**	Fe mottled
T076 P046	H	9.00	14.04	16.83	939.94	87.2	5.1	0.062	0.125	**1744.0**	micaceous
T076 P046	H	9.50	14.04	19.39	975.10	87.5	5.1	0.062	0.125	**873.8**	
T076 P046	H	10.00	14.04	32.56	341.31	88.2	5.1	0.062	0.125	**63.4**	mm-scale lamina
T076 P046	H	10.50	14.04	24.48	955.57	87.9	5.1	0.062	0.125	**380.7**	micaceous
T076 P046	H	11.00	14.04	18.73	988.28	88.2	5.1	0.062	0.125	**1030.6**	
T076 P046	H	11.50	14.04	18.43	1010.74	88.4	5.1	0.062	0.125	**1134.5**	
T076 P046	H	12.00	14.04	21.89	1021.97	88.6	5.1	0.062	0.125	**580.5**	
T076 P046	H	12.50	14.04	17.03	1041.02	88.9	5.1	0.062	0.125	**1794.7**	
T076 P046	H	13.00	14.04	18.53	1081.06	88.7	5.1	0.062	0.125	**1183.5**	
T076 P046	H	13.50	14.01	17.63	876.47	88.7	5.1	0.062	0.125	**1227.9**	Fe cemented
T076 P046	H	14.00	14.01	17.22	881.84	88.9	5.1	0.062	0.125	**1408.5**	Fe cemented
T076 P046	H	14.50	14.01	16.60	886.23	88.7	5.1	0.062	0.125	**1791.6**	mm-scale lamina
T076 P046	H	15.00	14.01	19.35	893.56	88.6	5.1	0.062	0.125	**804.2**	mm-scale lamina
T076 P046	H	15.50	14.01	15.81	898.93	88.7	5.1	0.062	0.125	**2690.6**	
T076 P046	H	16.00	14.06	16.08	1189.45	83.4	5.1	0.062	0.125	**3134.9**	
T076 P046	H	16.50	14.06	16.05	924.81	84.2	5.1	0.062	0.125	**2469.7**	
T076 P046	H	17.00	14.04	15.91	1370.61	78.4	5.1	0.062	0.125	**3916.2**	
T076 P046	H	17.50	14.04	16.14	1390.63	79.8	5.1	0.062	0.125	**3508.5**	

Minipermeameter Data from core T076 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T076 P046	H	18.00	14.04	17.51	1419.43	81.4	5.1	0.062	0.125	**2075.7**	
T076 P046	H	18.50	14.04	16.71	1441.90	82.2	5.1	0.062	0.125	**2805.5**	
T076 P046	H	19.00	14.04	16.10	1466.31	83.5	5.1	0.062	0.125	**3773.1**	
T076 P046	H	19.50	14.04	22.34	1499.02	83.8	5.1	0.062	0.125	**794.3**	highly micaceous
T076 P046	H	20.00	14.04	34.42	1433.59	84.5	5.1	0.062	0.125	**232.2**	highly Fe cemented
T076 P046	H	20.50	14.04	39.27	759.77	85.2	5.1	0.062	0.125	**90.4**	highly Fe cemented
T076 P046	H	21.00	14.04	43.41	6.07	86.1	5.1	0.062	0.125	**0.6**	Fe and calcite cemented
T076 P046	H	21.50	14.04	44.13	3.06	86.9	5.1	0.062	0.125	**0.3**	Fe and calcite cemented
T076 P046	H	22.00	14.04	36.90	1237.31	87.0	5.1	0.062	0.125	**170.1**	highly Fe cemented
T076 P046	H	22.50	14.04	16.08	1570.80	87.9	5.1	0.062	0.125	**4097.7**	suspect measurement
T076 P046	H	23.00	14.04	46.99	2.33	86.1	5.1	0.062	0.125	**0.2**	calcite cemented conglomerate
T076 P046	H	23.50	14.04	47.08	2.86	87.0	5.1	0.062	0.125	**0.2**	calcite cemented conglomerate
T076 P046	H	24.00	14.04	46.81	4.40	87.6	5.1	0.062	0.125	**0.4**	calcite cemented conglomerate

Appendix 2 (cont.)

Minipermeameter Data from core T104 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P014	H	2.50	13.98	17.20	1404.00	75.0	5.1	0.062	0.125	**2247.0**	
T104 P014	H	2.75	13.98	16.72	1456.00	75.8	5.1	0.062	0.125	**2761.0**	
T104 P014	H	3.00	13.98	16.58	1504.00	76.5	5.1	0.062	0.125	**3043.0**	
T104 P014	H	3.25	13.98	18.74	1479.00	77.3	5.1	0.062	0.125	**1526.0**	
T104 P014	H	3.50	13.98	17.38	1501.00	78.0	5.1	0.062	0.125	**2262.0**	
T104 P014	H	3.75	13.98	22.00	1518.00	78.8	5.1	0.062	0.125	**842.0**	
T104 P014	H	4.00	13.98	30.26	1539.00	79.5	5.1	0.062	0.125	**340.0**	
T104 P014	H	4.25	13.98	24.55	1537.00	80.3	5.1	0.062	0.125	**606.0**	
T104 P014	H	4.50	13.98	21.69	1541.00	81.0	5.1	0.062	0.125	**897.0**	
T104 P014	H	4.75	13.98	19.68	1549.00	81.8	5.1	0.062	0.125	**1297.0**	
T104 P014	H	5.00	13.98	21.15	1557.00	82.5	5.1	0.062	0.125	**988.0**	
T104 P014	H	5.25	13.98	22.95	1574.00	83.3	5.1	0.062	0.125	**765.0**	
T104 P014	H	5.50	13.98	17.57	1577.00	84.0	5.1	0.062	0.125	**2231.0**	
T104 P014	H	5.75	13.98	23.69	1594.00	84.8	5.1	0.062	0.125	**700.0**	
T104 P014	H	6.00	13.98	22.69	1606.00	85.5	5.1	0.062	0.125	**806.3**	
T104 P014	H	6.25	13.98	34.14	1622.00	86.3	5.1	0.062	0.125	**268.0**	
T104 P014	H	6.50	14.12	34.56	794.43	79.5	5.1	0.062	0.125	**127.6**	
T104 P014	H	6.75	14.12	16.76	1443.85	83.0	5.1	0.062	0.125	**2836.5**	
T104 P014	H	7.00	14.12	17.73	1457.52	83.7	5.1	0.062	0.125	**2033.4**	
T104 P014	H	7.25	14.12	17.35	1468.26	85.2	5.1	0.062	0.125	**2317.2**	
T104 P014	H	7.50	14.12	24.51	1484.86	85.5	5.1	0.062	0.125	**592.2**	slumped bedding
T104 P014	H	7.75	14.12	20.47	1490.23	86.2	5.1	0.062	0.125	**1086.4**	Fe mottling
T104 P014	H	8.00	14.12	27.80	1504.88	86.4	5.1	0.062	0.125	**420.4**	
T104 P014	H	8.25	14.12	26.07	1521.97	87.4	5.1	0.062	0.125	**507.3**	Slumped; Fe mottling
T104 P014	H	8.50	14.12	22.63	1544.43	86.7	5.1	0.062	0.125	**790.7**	
T104 P014	H	9.00	14.12	17.46	1565.43	87.6	5.1	0.062	0.125	**2382.0**	
T104 P014	H	9.25	14.12	16.11	690.92	88.4	5.1	0.062	0.125	**1839.3**	
T104 P014	H	9.50	14.12	16.65	695.80	88.7	5.1	0.062	0.125	**1433.2**	
T104 P014	H	9.75	14.12	24.51	703.13	88.4	5.1	0.062	0.125	**280.6**	
T104 P014	H	10.00	14.12	17.30	707.03	88.8	5.1	0.062	0.125	**1135.6**	
T104 P014	H	10.25	14.12	16.37	717.77	87.6	5.1	0.062	0.125	**1678.2**	
T104 P014	H	10.50	14.12	16.70	722.66	88.3	5.1	0.062	0.125	**1457.9**	
T104 P014	H	10.65	14.12	18.99	727.54	89.1	5.1	0.062	0.125	**722.5**	

Minipermeameter Data from core T104 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P014	H	10.75	14.12	18.70	733.89	88.9	5.1	0.062	0.125	**782.3**	
T104 P014	H	11.25	14.12	23.41	744.14	88.3	5.1	0.062	0.125	**341.8**	
T104 P014	H	11.50	14.12	19.18	743.65	88.5	5.1	0.062	0.125	**707.7**	Fe cement
T104 P014	H	11.75	14.12	17.85	748.05	88.6	5.1	0.062	0.125	**1006.6**	Fe cement
T104 P014	H	12.00	14.12	20.01	753.91	89.4	5.1	0.062	0.125	**601.4**	Fe cement
T104 P014	H	12.25	14.12	16.91	757.81	89.6	5.1	0.062	0.125	**1405.7**	Fe cement
T104 P014	H	12.50	14.12	21.78	1646.48	90.5	5.1	0.062	0.125	**960.1**	Fe cement - less than above
T104 P014	H	12.75	14.09	17.20	1601.56	81.1	5.1	0.062	0.125	**2629.6**	Fe cement - less than above
T104 P014	H	13.00	14.09	23.62	702.15	82.5	5.1	0.062	0.125	**312.4**	High amt. of Fe cem.
T104 P014	H	13.35	14.09	31.84	703.13	83.9	5.1	0.062	0.125	**138.0**	High amt. of Fe cem.
T104 P014	H	13.50	14.09	36.07	704.10	84.5	5.1	0.062	0.125	**102.2**	High amt. of Fe cem.
T104 P014	H	13.75	14.09	35.78	706.06	85.0	5.1	0.062	0.125	**104.5**	High amt. of Fe cem.
T104 P014	H	14.00	14.09	32.28	700.20	85.4	5.1	0.062	0.125	**132.9**	High amt. of Fe cem.
T104 P014	H	14.25	14.09	35.36	710.45	86.0	5.1	0.062	0.125	**108.1**	Fe and calcite cement
T104 P014	H	14.50	14.09	49.99	2.08	87.7	5.1	0.062	0.125	**0.1**	
T104 P014	H	14.75	14.09	49.99	4.69	88.9	5.1	0.062	0.125	**0.3**	
T104 P014	H	15.00	14.09	49.99	919.92	88.6	5.1	0.062	0.125	**64.1**	silty sandstone
T104 P014	H	15.25	14.09	34.50	4.07	87.5	5.1	0.062	0.125	**0.7**	
T104 P014	H	15.40	14.09	35.27	3.48	88.8	5.1	0.062	0.125	**0.5**	High amt. of Fe cem.
T104 P014	H	15.75	14.09	17.43	1257.32	89.2	5.1	0.062	0.125	**1910.5**	calcite cement
T104 P014	H	16.25	14.09	32.62	767.58	89.5	5.1	0.062	0.125	**142.1**	High amt. of Fe cem.
T104 P014	H	16.50	14.09	33.00	782.23	89.8	5.1	0.062	0.125	**140.8**	High amt. of Fe cem.
T104 P014	H	17.00	14.09	32.67	903.32	90.2	5.1	0.062	0.125	**166.6**	High amt. of Fe cem.
T104 P014	H	17.25	14.09	20.92	1327.15	90.2	5.1	0.062	0.125	**888.5**	High amt. of Fe cem.
T104 P014	H	17.50	14.09	26.65	1331.06	89.8	5.1	0.062	0.125	**416.8**	High amt. of Fe cem.
T104 P014	H	17.75	14.09	33.52	1029.79	90.2	5.1	0.062	0.125	**178.3**	High amt. of Fe cem.
T104 P014	H	18.00	14.09	20.25	1351.07	90.4	5.1	0.062	0.125	**1022.7**	Fe mottling
T104 P014	H	18.25	14.09	21.36	1363.77	90.8	5.1	0.062	0.125	**847.3**	Fe mottling
T104 P014	H	18.50	14.09	23.30	1381.84	91.2	5.1	0.062	0.125	**642.6**	Fe mottling
T104 P014	H	18.75	14.09	26.49	1387.70	91.4	5.1	0.062	0.125	**441.9**	Fe mottling
T104 P014	H	19.00	14.09	18.68	1401.86	90.5	5.1	0.062	0.125	**1493.7**	Fe mottling
T104 P014	H	19.25	14.09	19.12	1409.18	90.8	5.1	0.062	0.125	**1352.2**	Fe mottling
T104 P014	H	19.50	14.09	21.03	1416.50	91.0	5.1	0.062	0.125	**930.5**	Fe mottling
T104 P014	H	19.75	14.09	22.14	1423.34	91.2	5.1	0.062	0.125	**781.4**	Fe mottling
T104 P014	H	19.90	14.09	20.34	1451.66	91.0	5.1	0.062	0.125	**1081.2**	Fe mottling
T104 P014	H	20.00	14.09	30.70	1432.13	91.4	5.1	0.062	0.125	**308.4**	Fe mottling

Appendix 2 (cont.)

Minipermeameter Data from core T104 P030

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P030	H	8.50	14.04	17.14	1401.37	84.8	5.1	0.062	0.125	**2320.1**	
T104 P030	H	9.00	14.04	18.75	1427.25	85.3	5.1	0.062	0.125	**1478.6**	
T104 P030	H	9.50	14.04	17.57	1437.99	85.5	5.1	0.062	0.125	**2064.5**	
T104 P030	H	10.00	14.04	20.11	1453.13	86.1	5.1	0.062	0.125	**1123.0**	
T104 P030	H	10.50	14.04	17.31	1469.73	86.4	5.1	0.062	0.125	**2294.4**	
T104 P030	H	11.00	14.04	18.69	1489.26	86.7	5.1	0.062	0.125	**1566.5**	
T104 P030	H	11.50	14.04	19.41	1493.65	87.2	5.1	0.062	0.125	**1331.3**	
T104 P030	H	12.00	14.04	30.62	1507.81	87.2	5.1	0.062	0.125	**326.2**	
T104 P030	H	12.50	14.04	23.63	1515.14	87.4	5.1	0.062	0.125	**671.3**	
T104 P030	H	13.00	14.04	16.42	1562.01	89.1	5.1	0.062	0.125	**3451.3**	
T104 P030	H	13.50	14.04	21.66	1583.50	88.7	5.1	0.062	0.125	**932.9**	
T104 P030	H	14.00	14.04	19.19	1598.15	88.4	5.1	0.062	0.125	**1495.4**	
T104 P030	H	14.50	14.04	18.12	1608.89	88.6	5.1	0.062	0.125	**1965.7**	
T104 P030	H	15.00	14.04	17.16	1613.77	88.8	5.1	0.062	0.125	**2651.0**	
T104 P030	H	15.50	14.04	19.18	1625.00	89.3	5.1	0.062	0.125	**1525.0**	
T104 P030	H	16.00	14.04	17.43	1637.70	89.2	5.1	0.062	0.125	**2456.5**	
T104 P030	H	16.50	14.04	21.66	1655.27	89.5	5.1	0.062	0.125	**975.3**	
T104 P030	H	17.00	14.04	18.02	1666.50	89.6	5.1	0.062	0.125	**2092.9**	
T104 P030	H	17.50	14.04	28.33	1680.66	89.7	5.1	0.062	0.125	**444.6**	
T104 P030	H	18.00	14.04	18.86	1686.04	89.8	5.1	0.062	0.125	**1702.9**	Fe cement
T104 P030	H	18.50	14.03	21.56	1028.81	79.5	5.1	0.062	0.125	**613.6**	
T104 P030	H	19.00	14.03	18.52	1147.95	80.6	5.1	0.062	0.125	**1255.4**	Fe cement
T104 P030	H	19.50	14.03	16.81	1164.55	81.4	5.1	0.062	0.125	**2170.0**	
T104 P030	H	20.00	14.03	17.33	1176.27	82.0	5.1	0.062	0.125	**1813.4**	
T104 P030	H	20.50	14.03	16.13	1279.79	89.2	5.1	0.062	0.125	**3238.3**	
T104 P030	H	21.00	14.03	17.74	1320.31	89.7	5.1	0.062	0.125	**1794.6**	Fe cement
T104 P030	H	21.50	14.01	17.79	1380.86	89.3	5.1	0.062	0.125	**1844.2**	Cgl; Fe cemented
T104 P030	H	22.00	14.01	36.83	703.61	89.6	5.1	0.062	0.125	**97.2**	Fe cement
T104 P030	H	22.50	14.01	22.03	1395.02	88.7	5.1	0.062	0.125	**772.9**	
T104 P030	H	23.00	14.01	24.28	1402.83	88.7	5.1	0.062	0.125	**571.6**	
T104 P030	H	23.50	14.01	21.29	1417.97	89.2	5.1	0.062	0.125	**884.4**	
T104 P030	H	24.00	14.01	24.73	1429.69	89.3	5.1	0.062	0.125	**551.5**	
T104 P030	H	24.50	14.01	29.80	1448.73	89.0	5.1	0.062	0.125	**335.6**	

Appendix 2 (cont.)

Minipermeameter Data from core T104 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P046	H	3.50	14.01	30.23	1560.06	78.9	5.1	0.062	0.125	**347.7**	
T104 P046	H	4.00	14.01	25.42	1572.27	80.5	5.1	0.062	0.125	**559.2**	
T104 P046	H	4.50	14.01	21.24	1600.59	83.1	5.1	0.062	0.125	**1005.1**	
T104 P046	H	5.00	14.01	19.95	1605.96	84.6	5.1	0.062	0.125	**1275.7**	
T104 P046	H	5.50	14.01	20.95	1624.51	86.1	5.1	0.062	0.125	**1072.8**	
T104 P046	H	6.00	14.00	24.01	1620.12	83.3	5.1	0.062	0.125	**681.2**	
T104 P046	H	6.50	14.00	22.88	1640.63	83.6	5.1	0.062	0.125	**802.1**	
T104 P046	H	7.00	14.00	22.84	1648.44	86.3	5.1	0.062	0.125	**810.5**	
T104 P046	H	7.50	14.00	20.35	1659.67	87.0	5.1	0.062	0.125	**1218.7**	
T104 P046	H	8.00	14.00	20.61	1664.55	87.8	5.1	0.062	0.125	**1166.4**	
T104 P046	H	8.50	14.00	22.94	1676.27	88.6	5.1	0.062	0.125	**813.4**	
T104 P046	H	9.00	14.00	17.48	1689.45	88.8	5.1	0.062	0.125	**2470.7**	
T104 P046	H	9.50	14.00	37.33	1704.59	88.7	5.1	0.062	0.125	**228.0**	
T104 P046	H	10.00	14.00	49.99	910.65	88.8	5.1	0.062	0.125	**63.3**	Fe-rich
T104 P046	H	10.50	14.00	17.25	1103.03	86.9	5.1	0.062	0.125	**1740.5**	
T104 P046	H	11.00	14.00	17.32	1124.51	88.3	5.1	0.062	0.125	**1731.7**	
T104 P046	H	11.50	14.00	19.58	1144.04	88.7	5.1	0.062	0.125	**978.1**	Fe stains
T104 P046	H	12.00	14.00	16.20	1173.83	89.3	5.1	0.062	0.125	**2833.7**	
T104 P046	H	12.50	14.00	18.47	1190.43	89.5	5.1	0.062	0.125	**1314.6**	
T104 P046	H	13.00	14.00	25.53	1136.72	89.6	5.1	0.062	0.125	**399.8**	Fe stains
T104 P046	H	13.50	14.00	16.80	1219.24	89.6	5.1	0.062	0.125	**2268.8**	Fe stains
T104 P046	H	14.00	14.00	22.36	1227.54	90.1	5.1	0.062	0.125	**646.8**	slumped bedding
T104 P046	H	14.50	14.00	21.84	1237.79	90.3	5.1	0.062	0.125	**706.1**	Fe stains
T104 P046	H	15.00	14.00	16.41	1256.84	89.2	5.1	0.062	0.125	**2753.3**	
T104 P046	H	15.50	14.00	16.70	1278.32	89.4	5.1	0.062	0.125	**2472.5**	
T104 P046	H	16.00	14.00	19.10	1288.57	89.1	5.1	0.062	0.125	**1221.9**	
T104 P046	H	16.50	14.00	23.45	1303.71	89.6	5.1	0.062	0.125	**590.3**	
T104 P046	H	17.00	14.00	24.30	1310.55	89.5	5.1	0.062	0.125	**532.0**	
T104 P046	H	17.50	14.00	18.38	1320.80	89.6	5.1	0.062	0.125	**1490.9**	
T104 P046	H	18.00	14.00	20.63	1330.57	89.6	5.1	0.062	0.125	**928.6**	
T104 P046	H	18.50	14.00	21.50	1340.82	89.5	5.1	0.062	0.125	**807.3**	
T104 P046	H	19.00	14.00	29.25	1351.56	90.0	5.1	0.062	0.125	**328.4**	
T104 P046	H	19.50	14.00	19.15	1373.05	90.2	5.1	0.062	0.125	**1288.1**	

Minipermeameter Data from core T104 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P046	H	20.00	14.00	26.25	1387.70	90.0	5.1	0.062	0.125	**451.2**	
T104 P046	H	20.50	14.00	17.24	1399.41	90.6	5.1	0.062	0.125	**2219.0**	
T104 P046	H	21.00	14.00	18.47	1416.02	90.5	5.1	0.062	0.125	**1564.0**	
T104 P046	H	21.50	14.00	16.81	1429.69	90.2	5.1	0.062	0.125	**2648.0**	
T104 P046	H	22.00	14.00	18.71	1439.45	90.3	5.1	0.062	0.125	**1496.2**	
T104 P046	H	22.50	14.00	29.96	1458.50	90.6	5.1	0.062	0.125	**333.2**	
T104 P046	H	23.00	14.00	21.67	1474.12	91.0	5.1	0.062	0.125	**863.9**	Fe mottling
T104 P046	H	23.50	14.00	34.12	1487.79	91.1	5.1	0.062	0.125	**246.3**	Fe cement
T104 P046	H	24.00	14.00	46.83	4.98	91.6	5.1	0.062	0.125	**0.4**	Fe; calcite cement
T104 P046	H	24.50	14.00	47.19	3.89	91.8	5.1	0.062	0.125	**0.3**	Fe; calcite cement
T104 P046	H	25.00	14.00	46.56	8.24	92.1	5.1	0.062	0.125	**0.7**	Fe; calcite cement
T104 P046	H	25.50	14.00	46.80	6.59	92.3	5.1	0.062	0.125	**0.5**	Fe; calcite cement
T104 P046	H	26.00	14.00	47.08	8.79	92.6	5.1	0.062	0.125	**0.7**	calcite cement; Fe
T104 P046	H	26.50	14.00	47.38	5.42	92.6	5.1	0.062	0.125	**0.4**	calcite cement
T104 P046	H	27.00	14.00	47.66	4.42	92.4	5.1	0.062	0.125	**0.3**	calcite cement

Appendix 2 (cont.)

Minipermeameter Data from core T104 P062

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P062	H	5.00	14.06	23.66	715.82	78.1	5.1	0.062	0.125	**316.0**	
T104 P062	H	5.50	14.06	22.36	895.51	79.8	5.1	0.062	0.125	**473.4**	
T104 P062	H	6.00	14.06	23.22	832.52	80.7	5.1	0.062	0.125	**390.0**	
T104 P062	H	6.50	14.06	19.09	1064.94	83.4	5.1	0.062	0.125	**1021.8**	
T104 P062	H	7.00	14.06	21.70	1067.87	84.8	5.1	0.062	0.125	**625.3**	
T104 P062	H	7.50	14.06	22.73	1021.48	84.9	5.1	0.062	0.125	**512.7**	
T104 P062	H	8.00	14.06	23.12	1019.53	84.9	5.1	0.062	0.125	**484.5**	
T104 P062	H	8.50	14.06	20.59	1106.93	85.1	5.1	0.062	0.125	**782.8**	
T104 P062	H	9.00	14.06	21.75	1115.23	85.3	5.1	0.062	0.125	**648.1**	
T104 P062	H	9.50	14.06	23.15	1112.79	85.3	5.1	0.062	0.125	**527.1**	
T104 P062	H	10.00	14.06	19.71	1133.30	86.4	5.1	0.062	0.125	**950.4**	
T104 P062	H	10.50	14.06	16.44	1145.51	86.6	5.1	0.062	0.125	**2525.7**	
T104 P062	H	11.00	14.06	17.32	1160.65	87.5	5.1	0.062	0.125	**1817.0**	
T104 P062	H	11.50	14.06	16.35	1324.71	87.9	5.1	0.062	0.125	**3056.4**	
T104 P062	H	12.00	14.06	18.86	1338.87	87.6	5.1	0.062	0.125	**1357.5**	
T104 P062	H	12.50	14.06	18.20	1350.10	87.7	5.1	0.062	0.125	**1619.4**	
T104 P062	H	13.00	14.06	17.08	1359.86	87.9	5.1	0.062	0.125	**2319.5**	
T104 P062	H	13.50	14.06	25.65	1373.05	88.4	5.1	0.062	0.125	**478.1**	
T104 P062	H	14.00	14.06	20.28	1383.30	88.2	5.1	0.062	0.125	**1038.4**	
T104 P062	H	14.50	14.06	20.40	1388.18	86.9	5.1	0.062	0.125	**1018.1**	
T104 P062	H	15.00	14.06	17.25	1398.93	86.7	5.1	0.062	0.125	**2245.2**	
T104 P062	H	15.50	14.06	16.49	913.09	86.7	5.1	0.062	0.125	**1969.7**	
T104 P062	H	16.00	14.06	25.13	918.95	86.5	5.1	0.062	0.125	**339.0**	
T104 P062	H	16.50	14.06	33.67	809.57	86.7	5.1	0.062	0.125	**138.5**	
T104 P062	H	17.00	14.06	19.18	926.27	86.5	5.1	0.062	0.125	**872.3**	
T104 P062	H	17.50	14.06	17.33	927.73	87.2	5.1	0.062	0.125	**1446.3**	
T104 P062	H	18.00	14.06	16.27	933.11	87.7	5.1	0.062	0.125	**2229.5**	
T104 P062	H	18.50	14.06	16.96	937.50	88.0	5.1	0.062	0.125	**1673.1**	
T104 P062	H	19.00	14.06	16.91	942.87	87.4	5.1	0.062	0.125	**1714.1**	
T104 P062	H	19.50	14.06	17.80	948.73	86.9	5.1	0.062	0.125	**1276.4**	
T104 P062	H	20.00	14.06	15.64	955.57	87.0	5.1	0.062	0.125	**3271.5**	
T104 P062	H	20.50	14.06	16.06	959.96	87.0	5.1	0.062	0.125	**2548.5**	
T104 P062	H	21.00	14.04	17.32	838.87	83.2	5.1	0.062	0.125	**1303.3**	Fe mottled

Minipermeameter Data from core T104 P062

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P062	H	21.50	14.04	16.44	846.68	83.7	5.1	0.062	0.125	**1848.1**	Fe mottled
T104 P062	H	22.00	14.04	17.71	852.05	83.9	5.1	0.062	0.125	**1168.7**	Fe mottled
T104 P062	H	22.50	14.04	17.22	858.40	84.6	5.1	0.062	0.125	**1379.2**	Fe cemented
T104 P062	H	23.00	14.04	24.37	867.68	84.8	5.1	0.062	0.125	**350.1**	Fe cemented
T104 P062	H	23.50	14.04	32.07	862.31	85.3	5.1	0.062	0.125	**166.0**	Fe cemented conglomerate
T104 P062	H	24.00	14.04	45.28	2.84	85.3	5.1	0.062	0.125	**0.2**	Fe cemented conglomerate
T104 P062	H	24.50	14.04	44.45	4.27	86.2	5.1	0.062	0.125	**0.4**	Calcite cemented conglomerate
T104 P062	H	25.00	14.04	45.33	2.84	86.6	5.1	0.062	0.125	**0.2**	Calcite cemented conglomerate
T104 P062	H	25.50	14.04	45.44	3.61	87.0	5.1	0.062	0.125	**0.3**	Calcite cemented conglomerate
T104 P062	H	26.00	14.04	45.68	2.28	87.2	5.1	0.062	0.125	**0.2**	Calcite cemented conglomerate
T104 P062	H	26.50	14.04	45.47	3.92	87.3	5.1	0.062	0.125	**0.3**	Calcite cemented conglomerate
T104 P062	H	27.00	14.04	45.74	2.52	87.4	5.1	0.062	0.125	**0.2**	Calcite cemented conglomerate
T104 P062	H	27.50	14.04	45.74	2.80	87.6	5.1	0.062	0.125	**0.2**	Calcite cemented conglomerate

Appendix 2 (cont.)

Minipermeameter Data from core T104 P078

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P078	H	4.00	14.08	23.13	881.35	88.7	5.1	0.062	0.125	**418.9**	
T104 P078	H	4.50	14.08	22.61	954.10	89.0	5.1	0.062	0.125	**488.3**	
T104 P078	H	5.00	14.08	25.54	669.43	89.3	5.1	0.062	0.125	**236.2**	
T104 P078	H	5.50	14.08	24.79	773.93	89.5	5.1	0.062	0.125	**297.6**	
T104 P078	H	6.00	14.08	19.14	1001.47	89.9	5.1	0.062	0.125	**953.5**	
T104 P078	H	6.50	14.08	17.99	1010.25	90.1	5.1	0.062	0.125	**1288.1**	
T104 P078	H	7.00	14.08	18.18	1015.14	90.2	5.1	0.062	0.125	**1229.6**	
T104 P078	H	7.50	14.08	19.96	1021.48	90.4	5.1	0.062	0.125	**817.4**	Fe cemented
T104 P078	H	8.00	14.08	16.94	1031.25	90.6	5.1	0.062	0.125	**1857.1**	
T104 P078	H	8.50	14.08	16.20	1044.43	90.5	5.1	0.062	0.125	**2602.6**	
T104 P078	H	9.00	14.08	16.11	1045.41	90.7	5.1	0.062	0.125	**2722.0**	
T104 P078	H	9.50	14.08	16.80	1049.81	91.1	5.1	0.062	0.125	**2001.8**	
T104 P078	H	10.00	14.08	17.27	1065.92	91.4	5.1	0.062	0.125	**1703.8**	
T104 P078	H	10.50	14.08	16.44	859.86	91.6	5.1	0.062	0.125	**1906.8**	Fe mottled
T104 P078	H	11.00	14.08	16.79	872.56	92.1	5.1	0.062	0.125	**1672.3**	Fe mottled
T104 P078	H	11.50	14.08	16.33	880.37	91.8	5.1	0.062	0.125	**2054.7**	Fe mottled
T104 P078	H	12.00	14.08	16.33	881.84	91.4	5.1	0.062	0.125	**2058.0**	Fe mottled
T104 P078	H	12.50	14.08	15.93	883.79	90.7	5.1	0.062	0.125	**2543.7**	
T104 P078	H	13.00	14.08	17.00	888.67	90.0	5.1	0.062	0.125	**1563.7**	
T104 P078	H	13.50	14.08	17.69	896.97	90.8	5.1	0.062	0.125	**1252.4**	
T104 P078	H	14.00	14.08	16.53	899.90	90.5	5.1	0.062	0.125	**1920.3**	
T104 P078	H	14.50	14.08	15.99	900.88	89.9	5.1	0.062	0.125	**2504.8**	micaceous
T104 P078	H	15.00	14.08	18.76	909.67	90.1	5.1	0.062	0.125	**946.9**	micaceous
T104 P078	H	15.50	14.08	17.91	917.48	90.5	5.1	0.062	0.125	**1199.2**	micaceous
T104 P078	H	16.00	14.08	18.07	915.53	90.6	5.1	0.062	0.125	**1143.4**	
T104 P078	H	16.50	14.08	18.23	920.90	91.0	5.1	0.062	0.125	**1100.8**	micaceous
T104 P078	H	17.00	14.08	21.55	933.11	88.6	5.1	0.062	0.125	**561.6**	micaceous
T104 P078	H	17.50	14.08	17.26	931.64	89.3	5.1	0.062	0.125	**1494.9**	
T104 P078	H	18.00	14.08	15.64	940.92	89.7	5.1	0.062	0.125	**3247.0**	
T104 P078	H	18.50	14.08	18.52	947.27	89.4	5.1	0.062	0.125	**1047.8**	
T104 P078	H	19.00	14.08	17.51	950.20	89.4	5.1	0.062	0.125	**1405.2**	
T104 P078	H	19.50	14.08	23.77	959.96	89.4	5.1	0.062	0.125	**419.3**	
T104 P078	H	20.00	14.08	16.74	960.94	89.8	5.1	0.062	0.125	**1877.7**	

Minipermeameter Data from core T104 P078

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P078	H	20.50	14.08	16.30	966.31	90.0	5.1	0.062	0.125	**2294.5**	
T104 P078	H	21.00	14.08	17.60	968.26	90.3	5.1	0.062	0.125	**1388.3**	Fe cemented
T104 P078	H	21.50	14.08	16.64	976.07	90.4	5.1	0.062	0.125	**1986.4**	Fe mottled
T104 P078	H	22.00	14.08	17.51	982.91	90.6	5.1	0.062	0.125	**1453.9**	Fe mottled
T104 P078	H	22.50	14.08	18.48	984.86	90.6	5.1	0.062	0.125	**1100.0**	Fe mottled
T104 P078	H	23.00	14.04	18.68	1292.97	90.5	5.1	0.062	0.125	**1365.2**	Fe cemented
T104 P078	H	23.50	14.04	23.55	1375.00	90.7	5.1	0.062	0.125	**616.5**	Fe cemented
T104 P078	H	24.00	14.04	16.82	1440.43	90.8	5.1	0.062	0.125	**2687.4**	
T104 P078	H	24.50	14.04	18.34	1465.82	90.5	5.1	0.062	0.125	**1688.5**	micaceous
T104 P078	H	25.00	14.04	16.32	1483.89	90.6	5.1	0.062	0.125	**3431.0**	
T104 P078	H	26.00	14.04	47.10	3.20	91.0	5.1	0.062	0.125	**0.3**	Calcite cement
T104 P078	H	26.50	14.04	47.19	2.97	90.9	5.1	0.062	0.125	**0.2**	Calcite cement
T104 P078	H	27.00	14.04	16.77	1504.40	90.9	5.1	0.062	0.125	**2861.4**	highly Fe cemented
T104 P078	H	28.00	14.04	27.31	1597.66	90.2	5.1	0.062	0.125	**466.6**	highly Fe cemented
T104 P078	H	28.50	14.04	34.95	1596.68	90.2	5.1	0.062	0.125	**249.7**	highly Fe cemented

Appendix 2 (cont.)

Minipermeameter Data from core T104 P094

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P094	H	4.00	13.99	18.51	712.89	80.3	5.1	0.062	0.125	**776.5**	
T104 P094	H	4.50	13.99	19.20	637.21	81.2	5.1	0.062	0.125	**589.0**	
T104 P094	H	5.00	13.99	22.83	104.13	81.6	5.1	0.062	0.125	**51.2**	
T104 P094	H	5.50	13.99	19.76	652.83	81.8	5.1	0.062	0.125	**535.7**	
T104 P094	H	6.00	13.99	19.02	752.93	82.2	5.1	0.062	0.125	**725.4**	
T104 P094	H	6.50	13.99	18.91	782.72	82.7	5.1	0.062	0.125	**773.6**	
T104 P094	H	7.00	13.99	17.53	923.34	83.5	5.1	0.062	0.125	**1324.0**	
T104 P094	H	7.50	13.99	19.58	779.30	84.2	5.1	0.062	0.125	**664.4**	
T104 P094	H	8.00	13.99	18.15	932.13	84.7	5.1	0.062	0.125	**1115.0**	
T104 P094	H	8.50	13.99	15.82	974.12	85.8	5.1	0.062	0.125	**2856.8**	
T104 P094	H	9.00	13.99	16.17	987.31	87.0	5.1	0.062	0.125	**2398.5**	
T104 P094	H	9.50	13.99	15.88	1105.96	88.2	5.1	0.062	0.125	**3134.0**	
T104 P094	H	10.00	13.99	16.53	1120.12	88.6	5.1	0.062	0.125	**2315.4**	
T104 P094	H	10.50	13.99	19.60	906.74	88.6	5.1	0.062	0.125	**769.9**	
T104 P094	H	11.00	13.99	18.98	922.36	88.8	5.1	0.062	0.125	**897.5**	
T104 P094	H	11.50	13.99	15.98	935.55	89.2	5.1	0.062	0.125	**2513.3**	
T104 P094	H	12.00	13.99	20.25	935.06	89.3	5.1	0.062	0.125	**698.6**	
T104 P094	H	12.50	13.99	17.16	944.34	89.3	5.1	0.062	0.125	**1530.0**	
T104 P094	H	13.00	13.99	15.66	953.61	89.5	5.1	0.062	0.125	**3080.8**	
T104 P094	H	13.50	13.99	15.48	959.96	89.8	5.1	0.062	0.125	**3504.5**	
T104 P094	H	14.00	13.99	16.03	961.91	90.1	5.1	0.062	0.125	**2518.6**	
T104 P094	H	14.50	13.99	16.63	970.70	90.5	5.1	0.062	0.125	**1926.8**	Fe cemented
T104 P094	H	15.00	13.99	16.68	971.68	90.5	5.1	0.062	0.125	**1890.6**	
T104 P094	H	15.50	13.99	20.90	982.91	90.3	5.1	0.062	0.125	**653.3**	
T104 P094	H	16.00	13.99	18.67	978.52	90.2	5.1	0.062	0.125	**1026.9**	
T104 P094	H	16.50	13.99	16.64	989.26	90.2	5.1	0.062	0.125	**1953.7**	
T104 P094	H	17.00	13.99	16.54	995.12	90.0	5.1	0.062	0.125	**2046.9**	
T104 P094	H	17.50	13.99	16.48	1003.42	90.2	5.1	0.062	0.125	**2118.9**	Fe mottling
T104 P094	H	18.00	13.99	16.57	996.09	87.5	5.1	0.062	0.125	**2026.9**	
T104 P094	H	18.50	13.99	17.05	1010.74	87.9	5.1	0.062	0.125	**1701.9**	
T104 P094	H	19.00	13.99	15.48	898.44	88.1	5.1	0.062	0.125	**3278.8**	
T104 P094	H	19.50	13.99	17.26	907.23	88.1	5.1	0.062	0.125	**1421.2**	mm-scale lamina
T104 P094	H	20.00	13.99	17.71	910.65	88.3	5.1	0.062	0.125	**1235.7**	mm-scale lamina

Minipermeameter Data from core T104 P094

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T104 P094	H	20.50	13.99	17.76	915.04	88.6	5.1	0.062	0.125	**1223.8**	mm-scale lamina
T104 P094	H	21.00	13.99	15.81	924.81	88.8	5.1	0.062	0.125	**2733.2**	
T104 P094	H	22.50	13.99	31.57	385.62	89.2	5.1	0.062	0.125	**77.1**	highly Fe cemented
T104 P094	H	23.00	13.99	32.14	376.34	89.5	5.1	0.062	0.125	**72.0**	highly Fe cemented
T104 P094	H	23.50	13.99	28.00	932.13	89.2	5.1	0.062	0.125	**253.7**	mm-scale lamina
T104 P094	H	24.00	13.99	31.54	460.94	89.4	5.1	0.062	0.125	**92.4**	mm-scale lamina
T104 P094	H	24.50	13.99	21.89	950.68	89.3	5.1	0.062	0.125	**537.5**	
T104 P094	H	25.00	13.99	20.01	956.06	89.4	5.1	0.062	0.125	**748.6**	
T104 P094	H	25.50	13.99	17.98	961.43	89.2	5.1	0.062	0.125	**1206.8**	slightly Fe cemented
T104 P094	H	26.00	13.99	20.02	962.40	89.4	5.1	0.062	0.125	**751.8**	Fe cemented

Appendix 2 (cont.)

Minipermeameter Data from core T132 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T132 P014	H	2.75	14.01	16.36	1606.93	86.7	5.1	0.062	0.125	**3614.4**	
T132 P014	H	3.00	14.01	16.85	1615.72	87.0	5.1	0.062	0.125	**2960.2**	
T132 P014	H	3.25	14.01	19.82	1624.51	87.2	5.1	0.062	0.125	**1323.0**	
T132 P014	H	3.25	14.01	16.41	1633.79	87.5	5.1	0.062	0.125	**3594.7**	
T132 P014	H	3.50	14.01	18.84	1633.79	87.6	5.1	0.062	0.125	**1651.8**	
T132 P014	H	3.75	14.01	17.62	1656.25	87.9	5.1	0.062	0.125	**2328.8**	
T132 P014	H	3.75	14.01	16.83	1646.48	88.0	5.1	0.062	0.125	**3031.4**	
T132 P014	H	4.00	14.01	27.09	1671.39	88.3	5.1	0.062	0.125	**498.2**	sampled above boundary
T132 P014	H	4.00	14.01	16.65	1663.57	88.9	5.1	0.062	0.125	**3295.7**	sampled below boundary
T132 P014	H	4.25	14.01	33.94	1687.50	89.0	5.1	0.062	0.125	**283.0**	
T132 P014	H	4.25	14.01	22.86	1684.57	89.2	5.1	0.062	0.125	**826.8**	
T132 P014	H	4.50	14.01	19.41	1684.08	89.4	5.1	0.062	0.125	**1496.0**	
T132 P014	H	4.75	14.01	19.65	1691.41	89.3	5.1	0.062	0.125	**1427.0**	
T132 P014	H	5.00	14.01	32.17	1692.87	89.5	5.1	0.062	0.125	**323.5**	
T132 P014	H	5.00	14.01	25.42	1721.19	89.6	5.1	0.062	0.125	**613.4**	
T132 P014	H	5.25	14.01	18.10	1708.98	90.2	5.1	0.062	0.125	**2084.8**	
T132 P014	H	5.25	14.01	19.93	1709.96	90.4	5.1	0.062	0.125	**1363.2**	
T132 P014	H	5.50	14.01	22.07	1726.56	90.4	5.1	0.062	0.125	**951.6**	
T132 P014	H	5.75	14.01	22.85	1738.77	90.4	5.1	0.062	0.125	**855.1**	
T132 P014	H	6.00	14.01	20.40	1738.77	90.6	5.1	0.062	0.125	**1268.2**	sampled above boundary
T132 P014	H	6.00	14.01	19.43	1721.68	90.3	5.1	0.062	0.125	**1521.7**	sampled below boundary
T132 P014	H	6.15	13.99	21.11	1370.61	81.8	5.1	0.062	0.125	**877.6**	
T132 P014	H	6.15	13.99	19.26	1385.25	83.4	5.1	0.062	0.125	**1263.9**	
T132 P014	H	6.25	14.01	22.88	1733.40	90.3	5.1	0.062	0.125	**849.5**	
T132 P014	H	6.50	13.99	19.15	1396.00	85.6	5.1	0.062	0.125	**1305.8**	
T132 P014	H	6.70	13.99	26.69	1405.27	86.0	5.1	0.062	0.125	**435.7**	
T132 P014	H	6.80	13.99	19.73	1417.48	87.2	5.1	0.062	0.125	**1173.4**	
T132 P014	H	6.90	13.99	19.56	1422.85	87.9	5.1	0.062	0.125	**1220.3**	
T132 P014	H	7.10	13.99	20.79	1420.41	88.8	5.1	0.062	0.125	**962.2**	
T132 P014	H	7.25	13.99	19.30	1431.64	89.2	5.1	0.062	0.125	**1297.4**	
T132 P014	H	7.50	13.99	23.94	1440.92	89.8	5.1	0.062	0.125	**611.8**	
T132 P014	H	7.75	13.99	20.39	1452.15	90.3	5.1	0.062	0.125	**1058.2**	
T132 P014	H	7.80	13.99	22.31	1453.61	90.6	5.1	0.062	0.125	**770.7**	

Minipermeameter Data from core T132 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T132 P014	H	8.10	13.99	35.69	1475.59	90.8	5.1	0.062	0.125	**219.3**	
T132 P014	H	8.50	13.99	18.62	1469.24	91.4	5.1	0.062	0.125	**1560.9**	
T132 P014	H	8.75	13.99	19.39	1480.47	91.5	5.1	0.062	0.125	**1317.6**	
T132 P014	H	8.85	13.99	18.70	1496.09	91.9	5.1	0.062	0.125	**1556.7**	
T132 P014	H	9.00	13.99	29.29	1510.74	92.1	5.1	0.062	0.125	**365.8**	
T132 P014	H	9.25	13.99	17.07	1523.44	92.3	5.1	0.062	0.125	**2556.1**	
T132 P014	H	9.50	13.99	23.80	1525.39	92.1	5.1	0.062	0.125	**659.1**	
T132 P014	H	9.75	13.99	22.35	1539.55	92.3	5.1	0.062	0.125	**812.1**	
T132 P014	H	10.00	13.99	20.96	1571.29	92.0	5.1	0.062	0.125	**1033.8**	
T132 P014	H	10.25	13.99	21.33	1558.11	92.2	5.1	0.062	0.125	**963.9**	
T132 P014	H	10.50	13.99	25.65	1564.94	92.6	5.1	0.062	0.125	**542.9**	
T132 P014	H	10.75	13.99	19.80	1591.31	92.6	5.1	0.062	0.125	**1299.2**	
T132 P014	H	11.00	13.99	18.75	1582.52	92.9	5.1	0.062	0.125	**1627.6**	
T132 P014	H	11.25	13.99	28.94	1612.31	92.8	5.1	0.062	0.125	**402.6**	
T132 P014	H	11.50	13.99	22.52	1609.38	92.8	5.1	0.062	0.125	**628.1**	
T132 P014	H	11.75	13.99	21.69	1611.33	92.8	5.1	0.062	0.125	**939.8**	
T132 P014	H	11.90	13.99	20.09	1611.33	93.1	5.1	0.062	0.125	**1241.7**	
T132 P014	H	12.00	13.98	20.15	1073.24	86.7	5.1	0.062	0.125	**815.1**	
T132 P014	H	12.25	13.98	17.74	1086.91	87.2	5.1	0.062	0.125	**1459.6**	
T132 P014	H	12.50	13.98	19.26	1098.63	88.9	5.1	0.062	0.125	**1001.6**	
T132 P014	H	12.75	13.98	20.53	1107.42	89.5	5.1	0.062	0.125	**784.3**	
T132 P014	H	12.85	13.98	17.44	1127.44	91.4	5.1	0.062	0.125	**1658.7**	
T132 P014	H	12.90	13.98	18.68	1135.74	91.8	5.1	0.062	0.125	**1186.1**	
T132 P014	H	13.00	13.98	31.87	1089.84	91.8	5.1	0.062	0.125	**212.9**	
T132 P014	H	13.25	13.98	20.03	1146.48	92.2	5.1	0.062	0.125	**892.4**	
T132 P014	H	13.50	13.98	19.43	494.26	92.0	5.1	0.062	0.125	**512.5**	
T132 P014	H	13.50	13.98	16.54	1280.27	92.0	5.1	0.062	0.125	**2622.9**	
T132 P014	H	13.75	13.98	18.09	644.53	92.6	5.1	0.062	0.125	**783.2**	
T132 P014	H	14.00	13.98	18.19	650.39	93.0	5.1	0.062	0.125	**769.7**	
T132 P014	H	14.25	13.98	15.66	654.79	93.0	5.1	0.062	0.125	**2102.3**	
T132 P014	H	14.50	13.98	15.89	656.74	92.8	5.1	0.062	0.125	**1838.9**	
T132 P014	H	14.75	13.98	19.87	664.55	92.6	5.1	0.062	0.125	**533.7**	
T132 P014	H	15.00	13.98	16.53	666.50	93.0	5.1	0.062	0.125	**1372.8**	
T132 P014	H	15.25	13.98	17.22	672.36	93.1	5.1	0.062	0.125	**1063.9**	
T132 P014	H	15.50	13.98	34.30	674.81	93.0	5.1	0.062	0.125	**110.2**	
T132 P014	H	15.75	13.98	16.39	684.57	93.9	5.1	0.062	0.125	**1495.2**	mica-bounded sandy lamina

Minipermeameter Data from core T132 P014

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T132 P014	H	16.00	13.98	20.17	687.50	93.6	5.1	0.062	0.125	**521.6**	mica-bounded sandy lamina
T132 P014	H	16.25	13.98	22.02	698.73	93.6	5.1	0.062	0.125	**386.8**	mica-bounded sandy lamina
T132 P014	H	16.50	13.98	15.71	693.85	93.6	5.1	0.062	0.125	**2161.6**	
T132 P014	H	16.75	13.98	21.48	694.82	93.8	5.1	0.062	0.125	**418.4**	Fe-rich
T132 P014	H	17.00	13.98	34.34	698.73	93.9	5.1	0.062	0.125	**113.9**	Fe-rich
T132 P014	H	17.50	13.98	24.89	706.06	93.3	5.1	0.062	0.125	**266.9**	Fe-rich
T132 P014	H	18.00	13.98	40.96	389.89	93.6	5.1	0.062	0.125	**42.2**	Fe-rich
T132 P014	H	18.25	13.98	45.57	3.42	93.5	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	18.50	13.98	45.03	6.51	93.6	5.1	0.062	0.125	**0.6**	calcite cement
T132 P014	H	18.75	13.98	45.70	2.61	94.0	5.1	0.062	0.125	**0.2**	calcite cement
T132 P014	H	19.00	13.98	45.67	3.74	94.0	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	19.25	13.98	45.94	2.42	94.2	5.1	0.062	0.125	**0.2**	calcite cement
T132 P014	H	19.50	13.98	45.61	3.97	94.0	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	19.75	13.98	45.09	3.58	93.3	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	20.00	13.98	45.67	4.92	92.7	5.1	0.062	0.125	**0.4**	calcite cement
T132 P014	H	20.25	13.98	44.15	39.49	92.8	5.1	0.062	0.125	**3.6**	calcite cement
T132 P014	H	20.50	13.98	40.92	457.89	92.7	5.1	0.062	0.125	**49.6**	calcite cement
T132 P014	H	20.75	13.98	45.92	4.46	92.8	5.1	0.062	0.125	**0.4**	calcite cement
T132 P014	H	21.00	13.98	45.80	5.73	93.2	5.1	0.062	0.125	**0.5**	calcite cement
T132 P014	H	21.25	13.98	46.20	4.18	93.3	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	21.50	13.98	45.80	4.46	93.0	5.1	0.062	0.125	**0.4**	calcite cement
T132 P014	H	21.75	13.98	45.41	4.14	92.9	5.1	0.062	0.125	**0.4**	calcite cement
T132 P014	H	22.00	13.98	46.17	4.04	93.0	5.1	0.062	0.125	**0.3**	calcite cement
T132 P014	H	22.25	13.98	45.22	27.67	93.6	5.1	0.062	0.125	**2.4**	calcite cement
T132 P014	H	22.50	13.98	46.36	7.04	93.8	5.1	0.062	0.125	**0.6**	calcite cement
T132 P014	H	22.75	13.98	46.47	7.75	94.0	5.1	0.062	0.125	**0.6**	calcite cement

Appendix 2 (cont.)

Minipermeameter Data from core T132 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T132 P046	H	7.00	14.03	16.49	890.14	84.8	5.1	0.062	0.125	**1893.1**	
T132 P046	H	7.50	14.03	18.03	918.46	85.7	5.1	0.062	0.125	**1145.5**	
T132 P046	H	8.00	14.03	18.90	927.73	86.4	5.1	0.062	0.125	**926.3**	
T132 P046	H	8.50	14.03	20.22	924.32	86.7	5.1	0.062	0.125	**698.3**	
T132 P046	H	9.00	14.03	24.13	438.11	87.2	5.1	0.062	0.125	**181.9**	on boundary
T132 P046	H	9.00	14.03	17.14	949.22	87.2	5.1	0.062	0.125	**1566.8**	above boundary
T132 P046	H	9.50	14.03	23.15	799.32	87.2	5.1	0.062	0.125	**377.6**	
T132 P046	H	10.00	14.03	19.51	955.08	87.4	5.1	0.062	0.125	**832.1**	
T132 P046	H	10.50	14.03	17.49	958.98	87.8	5.1	0.062	0.125	**1405.5**	Fe cemented
T132 P046	H	11.00	14.03	16.58	968.75	88.3	5.1	0.062	0.125	**1987.2**	
T132 P046	H	11.50	14.03	20.84	969.24	88.5	5.1	0.062	0.125	**653.7**	mm-scale lamina
T132 P046	H	12.00	14.03	17.31	979.98	88.6	5.1	0.062	0.125	**1525.5**	
T132 P046	H	12.50	14.03	16.21	994.14	88.9	5.1	0.062	0.125	**2410.2**	
T132 P046	H	13.00	14.03	16.30	988.77	89.0	5.1	0.062	0.125	**2300.5**	
T132 P046	H	13.50	14.03	18.98	996.58	89.2	5.1	0.062	0.125	**975.9**	mm-scale lamina
T132 P046	H	14.00	14.03	23.72	961.43	89.3	5.1	0.062	0.125	**421.0**	slumped
T132 P046	H	14.50	14.03	16.32	1004.88	89.4	5.1	0.062	0.125	**2311.5**	
T132 P046	H	15.00	14.03	16.55	1010.25	89.6	5.1	0.062	0.125	**2094.6**	
T132 P046	H	15.50	14.03	22.17	892.09	89.6	5.1	0.062	0.125	**485.0**	mm-scale lamina
T132 P046	H	16.00	14.03	18.92	893.56	89.7	5.1	0.062	0.125	**887.6**	laminated; Fe cemented
T132 P046	H	16.50	14.03	17.52	893.56	89.8	5.1	0.062	0.125	**1300.0**	slumped
T132 P046	H	17.00	14.03	19.97	901.37	89.9	5.1	0.062	0.125	**714.5**	slumped
T132 P046	H	17.50	14.03	16.05	905.76	90.0	5.1	0.062	0.125	**2381.0**	
T132 P046	H	18.00	14.03	17.40	905.76	87.0	5.1	0.062	0.125	**1370.0**	laminated
T132 P046	H	18.50	14.03	16.94	908.20	87.1	5.1	0.062	0.125	**1609.5**	laminated
T132 P046	H	19.00	14.03	16.06	913.09	87.2	5.1	0.062	0.125	**2383.5**	laminated
T132 P046	H	19.50	14.03	17.59	922.85	87.2	5.1	0.062	0.125	**1311.3**	mm-scale lamina
T132 P046	H	20.00	14.03	18.07	931.64	87.3	5.1	0.062	0.125	**1150.5**	
T132 P046	H	20.50	14.03	16.31	938.48	87.5	5.1	0.062	0.125	**2170.3**	
T132 P046	H	21.00	14.03	18.27	950.20	87.5	5.1	0.062	0.125	**1108.9**	
T132 P046	H	21.50	14.03	15.64	948.24	87.7	5.1	0.062	0.125	**3177.0**	
T132 P046	H	22.00	14.03	16.13	1303.22	88.1	5.1	0.062	0.125	**3296.9**	
T132 P046	H	22.50	14.03	17.11	916.99	88.2	5.1	0.062	0.125	**1527.1**	Fe mottling

Minipermeameter Data from core T132 P046

Core	type	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	Exter. R	*Ka* (md)	Comments
T132 P046	H	23.00	14.03	24.78	921.39	88.3	5.1	0.062	0.125	**353.6**	Fe mottling
T132 P046	H	23.50	14.03	36.21	112.92	88.6	5.1	0.062	0.125	**16.2**	Fe cemented conglomerate
T132 P046	H	24.00	14.03	34.01	403.44	88.4	5.1	0.062	0.125	**67.3**	Fe cemented
T132 P046	H	24.50	14.03	40.64	2.25	89.3	5.1	0.062	0.125	**0.2**	calcite cemented conglomerate
T132 P046	H	25.00	14.03	39.58	2.88	89.9	5.1	0.062	0.125	**0.3**	calcite cemented sandstone
T132 P046	H	25.50	14.03	40.04	3.43	90.3	5.1	0.062	0.125	**0.4**	calcite cemented conglomerate
T132 P046	H	26.00	14.03	35.41	295.90	89.9	5.1	0.062	0.125	**44.8**	silty conglomeratic sandstone
T132 P046	H	26.50	14.03	40.45	2.54	90.2	5.1	0.062	0.125	**0.3**	Fe cemented conglomerate
T132 P046	H	26.90	14.03	33.53	689.94	90.2	5.1	0.062	0.125	**119.2**	Fe cemented sandstone

Appendix 3 - Data for Laboratory Core Plugs - Horizontal Ka measurements

Minipermeameter Data										Laboratory Data			
Core #	depth (ft)	Atm. P (psi)	Upstream P (psi)	*Flow Rate* (CC/min)	*Temp.* (deg. F)	Geometric Factor	*Tip Radius (inch.)* Inter. R	exter. R	*Ka* (md)	*Ka* (md)	*Porosity* (%)	*Grain Density* (g/cc)	*Comments*
T132 P014	2.9	13.97	16.65	1437.50	87.3	5.1	0.062	0.125	2799.7	2622.0	36.4	2.70	
T132 P014	4.1	13.97	16.42	1477.05	90.0	5.1	0.062	0.125	3174.4	3192.0	36.4	2.69	
T132 P014	5.2	13.97	16.52	1501.47	90.8	5.1	0.062	0.125	3093.9	2345.0	35.4	2.67	
T132 P014	6.2	13.97	19.93	1519.04	91.1	5.1	0.062	0.125	1203.0	1204.0	35.2	2.70	
T132 P014	7.0	13.97	18.88	1525.39	91.4	5.1	0.062	0.125	1512.7	1296.0	35.8	2.69	
T132 P014	7.9	13.97	23.41	1543.95	92.0	5.1	0.062	0.125	700.7	656.0	33.3	2.67	
T132 P014	8.9	13.97	19.36	1557.62	91.7	5.1	0.062	0.125	1388.3	1590.0	33.0	2.68	
T132 P014	10.0	13.97	19.68	1572.75	91.5	5.1	0.062	0.125	1311.4	1665.0	33.7	2.68	
T132 P014	10.9	13.97	19.59	1577.15	92.1	5.1	0.062	0.125	1338.6	1637.0	33.4	2.68	
T132 P014	11.9	13.97	18.80	1588.38	92.5	5.1	0.062	0.125	1607.5	1672.0	30.8	2.67	
T132 P014	12.9	13.97	20.14	1601.07	92.6	5.1	0.062	0.125	1218.2	1350.0	30.8	2.67	
T132 P014	14.0	13.97	24.18	1625.49	92.6	5.1	0.062	0.125	668.5	900.0	29.7	2.68	
T132 P014	15.0	13.97	20.07	1617.19	92.9	5.1	0.062	0.125	1248.0	1375.0	33.1	2.68	
T132 P014	17.0	13.97	46.46	1198.73	93.2	5.1	0.062	0.125	97.9	168.0	45.0	2.76	cemented
T132 P014	18.0	13.97	46.40	1379.88	93.5	5.1	0.062	0.125	113.0	80.0	48.2	2.79	cemented
T132 P014	19.0	13.97	49.99	3.74	93.7	5.1	0.062	0.125	0.3	0.02	4.0	2.66	cemented
T132 P014	20.0	13.97	49.99	4.48	94.2	5.1	0.062	0.125	0.3	0.04	9.3	2.78	cemented
T132 P014	21.0	13.97	49.99	4.52	94.6	5.1	0.062	0.125	0.3	0.01	2.0	2.68	cemented
T132 P014	22.0	13.97	49.99	5.73	93.9	5.1	0.062	0.125	0.4	0.04	6.9	2.69	cemented
T132 P014	23.0	13.97	49.99	2.21	94.1	5.1	0.062	0.125	0.2	0.01	7.5	2.72	cemented
T104 P014	2.8	13.97	15.96	1261.72	90.6	5.1	0.062	0.125		1767.0	36.2	2.66	frac. before miniK
T104 P014	3.8	13.97	20.26	1273.93	91.1	5.1	0.062	0.125	946.9	1023.0	36.6	2.66	
T104 P014	4.8	13.97	17.19	1294.92	91.6	5.1	0.062	0.125	2067.1	1455.0	34.0	2.66	
T104 P014	5.8	13.97	18.07	1299.32	91.8	5.1	0.062	0.125	1585.0	1292.0	34.8	2.67	
T104 P014	6.8	13.97	16.63	1313.97	92.4	5.1	0.062	0.125	2587.1	2088.0	33.7	2.67	
T104 P014	7.8	13.97	17.58	1331.06	92.8	5.1	0.062	0.125	1872.1	1692.0	35.1	2.65	
T104 P014	8.8	13.97	17.83	1340.82	92.9	5.1	0.062	0.125	1746.7	1644.0	35.5	2.66	
T104 P014	9.8	13.97	16.80	1363.77	92.8	5.1	0.062	0.125	2509.3	2003.0	35.8	2.67	
T104 P014	11.9	13.97	18.45	1376.95	92.8	5.1	0.062	0.125	1520.2	1213.0	35.6	2.68	
T104 P014	12.8	13.97	16.80	1387.70	93.0	5.1	0.062	0.125	2553.5	2592.0	36.7	2.67	
T104 P014	13.8	13.97	38.20	979.49	93.2	5.1	0.062	0.125	124.2	136.0	35.5	2.73	cemented
T104 P014	14.7	13.97	42.93	5.14	93.9	5.1	0.062	0.125	0.5	0.04	8.4	2.71	cemented
T104 P014	15.9	13.97	43.84	1.39	94.1	5.1	0.062	0.125	0.1	0.04	4.3	2.66	cemented
T104 P014	16.7	13.97	42.99	7.20	94.3	5.1	0.062	0.125	0.7	0.58	12.5	2.71	cemented congl.
T104 P014	18.1	13.97	19.95	1404.30	94.1	5.1	0.062	0.125	1110.0	1384.0	32.7	2.67	
T104 P014	18.9	13.97	18.47	1417.48	94.1	5.1	0.062	0.125	1555.6	1562.0	32.1	2.66	
T104 P014	19.9	13.97	20.04	1425.29	94.1	5.1	0.062	0.125	1105.3	1102.0	29.7	2.69	

Appendix 4 - Thin section analyses of Hwy 7 cores behind outcrop. Locations of cores are shown in Figure 4.
Thin section locations are shown to the right of core descriptions in Appendix 1 and on Plate 1.

Core #	Thin section #	Sample Depth (ft)	Avg. Qtz. Grain Size (mm)	Sorting	Approx. sphericity index	roundness	mica (%)	clay (%)	cement (%)	Comments	Porosity (%)	Ka (md)	Grain Density (g/cc)
T132P014	1	2.9	0.17	well sorted	0.75	subrounded	2.00	0.50	4.00	Fe-oxide cement	36.4	2622	2.70
T132P014	2	4.1	0.15	well sorted	0.71	subrounded	2.25	0.75	2.00	Fe-oxide cement	36.4	3192	2.69
T132P014	3	5.2	0.14	well sorted	0.67	subangular	4.00	1.00	4.00	Fe-oxide cement	35.4	2345	2.67
T132P014	4	6.2	0.11	moderately sorted	0.69	subangular	4.75	1.00	3.00	Fe-oxide cement	35.2	1204	2.70
T132P014	5	7.0	0.12	well sorted	0.71	subangular	6.25	1.50	3.00	Fe-oxide cement	35.8	1296	2.69
T132P014	6	7.9	0.11	well sorted	0.67	subangular	8.50	2.00	3.00	Fe-oxide cement	33.3	656	2.67
T132P014	7	8.9	0.14	very well sorted	0.71	subrounded	2.50	1.50	4.00	Fe-oxide cement	33.0	1590	2.68
T132P014	8	10.0	0.14	very well sorted	0.71	subrounded	2.75	2.00	3.00	Fe-oxide cement	33.7	1665	2.68
T132P014	9	10.9	0.12	very well sorted	0.69	subrounded	2.00	3.00	4.00	Fe-oxide cement	33.4	1637	2.68
T132P014	10	11.9	0.15	very well sorted	0.73	subrounded	1.75	2.00	4.00	Fe-oxide cement	30.8	1672	2.67
T132P014	11	12.9	0.14	well sorted	0.71	subangular	4.25	3.00	5.00	Fe-oxide cement	30.8	1350	2.67
T132P014	12	14.0	0.09	well sorted	0.67	subangular	5.25	5.00	3.00	Fe-oxide cement	29.7	900	2.68
T132P014	13	15.0	0.14	well sorted	0.71	subangular	4.25	5.00	3.00	Fe-oxide cement	33.1	1375	2.68
T132P014	14	17.0	0.17	very well sorted	0.73	subrounded	1.25	4.00	40.00	Fe-oxide cement	45.0	168	2.76
T132P014	15	18.0	0.14	very well sorted	0.73	subrounded	0.75	6.00	50.00	Fe-oxide cement; shale clasts	48.2	80	2.79
T132P014	16	19.0	0.15	very well sorted	0.71	subrounded	1.38	3.00	40.00	calcite cement; shale clasts	4.0	0.02	2.66
T132P014	17	20.0	0.09	very poorly sorted	0.67	subangular	0.50	20.00	30.00	calcite cemented cgl.	9.3	0.04	2.78
T132P014	18	21.0	0.09	very well sorted	0.73	rounded	0.75	1.00	45.00	calcite cement	2.0	0.01	2.68
T132P014	19	22.0	0.11	very well sorted	0.65	subangular	0.50	2.00	45.00	calcite cement; Fe-oxide cement	6.9	0.04	2.69
T132P014	20	22.9	0.12	well sorted	0.69	subrounded	0.75	4.00	30.00	Fe-oxide cement; shale clasts	7.5	0.01	2.72
T104P014	21	2.8	0.12	well sorted	0.71	subrounded	2.25	2.00	2.00	Fe-oxide cement	36.2	1767	2.66
T104P014	22	3.8	0.11	moderately sorted	0.73	subangular	6.25	4.00	5.00	Fe-oxide cement	36.6	1023	2.66
T104P014	23	4.8	0.12	well sorted	0.71	subrounded	3.75	2.50	2.00	Fe-oxide cement	34.0	1455	2.66
T104P014	24	5.8	0.12	moderately sorted	0.69	subangular	6.25	4.00	3.00	Fe-oxide cement	34.8	1292	2.67
T104P014	25	6.8	0.15	well sorted	0.71	subrounded	1.50	2.00	5.00	Fe-oxide cement	33.7	2088	2.67
T104P014	26	7.8	0.14	well sorted	0.71	subrounded	1.25	4.00	3.00	Fe-oxide cement; shale clasts	35.1	1692	2.65
T104P014	27	8.8	0.14	well sorted	0.73	subrounded	3.00	3.00	2.00	Fe-oxide cement	35.5	1644	2.66
T104P014	28	9.8	0.15	well sorted	0.75	subrounded	2.25	4.00	3.00	Fe-oxide cement	35.8	2003	2.67
T104P014	29	11.9	0.14	well sorted	0.73	subrounded	1.50	5.00	12.00	Fe-oxide cement	35.6	1213	2.68
T104P014	30	12.8	0.15	well sorted	0.71	subangular	1.13	2.00	2.00	Fe-oxide cement	36.7	2592	2.67
T104P014	31	13.8	0.12	well sorted	0.69	subangular	3.00	4.00	20.00	Fe-oxide cement	35.5	136	2.73
T104P014	32	14.7	0.14	well sorted	0.73	subangular	1.13	2.00	40.00	Fe-oxide cement; calcite cement	8.4	0.04	2.71
T104P014	33	15.9	0.12	moderately sorted	0.67	subrounded	0.75	6.00	45.00	calcite cement; shale clasts	4.3	0.04	2.66
T104P014	34	16.7	0.14	well sorted	0.71	subrounded	0.63	8.00	35.00	calcite and Fe-oxide cement; shale clasts	12.5	0.58	2.71
T104P014	35	18.1	0.11	well sorted	0.73	subrounded	1.13	2.00	4.00	Fe-oxide cement	32.7	1384	2.67
T104P014	36	18.9	0.12	well sorted	0.75	subrounded	0.88	2.00	4.00	Fe-oxide cement	32.1	1562	2.66
T104P014	37	19.9	0.11	well sorted	0.75	subrounded	0.75	2.00	5.00	Fe-oxide cement	29.7	1102	2.69

Appendix 5 - Lab and minipermeameter Ka values and statistics for plugs

All Samples

Core #	Depth (ft)	LabK Ka (md)	miniK Ka (md)	% differ.
T132 P014	2.9	2622.0	2799.7	#REF!
T132 P014	4.1	3192.0	3174.4	#REF!
T132 P014	5.2	2345.0	3093.9	#REF!
T132 P014	6.2	1204.0	1203.0	#REF!
T132 P014	7.0	1296.0	1512.7	#REF!
T132 P014	7.9	656.0	700.7	#REF!
T132 P014	8.9	1590.0	1388.3	#REF!
T132 P014	10.0	1665.0	1311.4	#REF!
T132 P014	10.9	1637.0	1338.6	#REF!
T132 P014	11.9	1672.0	1607.5	#REF!
T132 P014	12.9	1350.0	1218.2	#REF!
T132 P014	14.0	900.0	668.5	#REF!
T132 P014	15.0	1375.0	1248.0	#REF!
T132 P014	17.0	168.0	97.9	#REF!
T132 P014	18.0	80.0	113.0	#REF!
T132 P014	19.0	0.02	0.3	
T132 P014	20.0	0.04	0.3	
T132 P014	21.0	0.01	0.3	
T132 P014	22.0	0.04	0.4	
T132 P014	22.9	0.01	0.2	
T104 P014	3.8	1023.0	946.9	#REF!
T104 P014	4.8	1455.0	2067.1	#REF!
T104 P014	5.8	1292.0	1585.0	#REF!
T104 P014	6.8	2088.0	2587.1	#REF!
T104 P014	7.8	1692.0	1872.1	#REF!
T104 P014	8.8	1644.0	1746.7	#REF!
T104 P014	9.8	2003.0	2509.3	#REF!
T104 P014	11.9	1213.0	1520.2	#REF!
T104 P014	12.8	2592.0	2553.5	#REF!
T104 P014	13.8	136.0	124.2	#REF!
T104 P014	14.7	0.04	0.5	
T104 P014	15.9	0.04	0.1	
T104 P014	16.7	0.58	0.7	
T104 P014	18.1	1384.0	1110.0	#REF!
T104 P014	18.9	1562.0	1555.6	#REF!
T104 P014	19.9	1102.0	1105.3	#REF!

Uncemented Samples
Laboratory Analyses

Core #	Depth (ft)	Porosity (%)	Ka (md)
T132P014	2.9	36.4	2622.0
T132P014	4.1	36.4	3192.0
T132P014	5.2	35.4	2345.0
T132P014	6.2	35.2	1204.0
T132P014	7.0	35.8	1296.0
T132P014	7.9	33.3	656.0
T132P014	8.9	33.0	1590.0
T132P014	10.0	33.7	1665.0
T132P014	10.9	33.4	1637.0
T132P014	11.9	30.8	1672.0
T132P014	12.9	30.8	1350.0
T132P014	14.0	29.7	900.0
T132P014	15.0	33.1	1375.0
T104P014	2.8	36.2	1767.0
T104P014	3.8	36.6	1023.0
T104P014	4.8	34.0	1455.0
T104P014	5.8	34.8	1292.0
T104P014	6.8	33.7	2088.0
T104P014	7.8	35.1	1692.0
T104P014	8.8	35.5	1644.0
T104P014	9.8	35.8	2003.0
T104P014	11.9	35.6	1213.0
T104P014	12.8	36.7	2592.0
T104P014	18.1	32.7	1384.0
T104P014	18.9	32.1	1562.0
T104P014	19.9	29.7	1102.0

Uncemented Samples
Laboratory Analyses

Ka Statistics		*Phi Statistics*
n	26	26
Geom. Mean	1537.53	
Arithmetic Mean	1627.73	34.06
Standard Error	112.22	0.42
Median	1576.00	34.40
Standard Deviation	572.22	2.12
Sample Variance	327437.88	4.50
Kurtosis	1.18	-0.45
Skewness	0.99	-0.70
Range	2536.00	7.00
Minimum	656.00	29.70
Maximum	3192.00	36.70
Sum	42321.00	885.50

Uncemented Samples
Minipermeameter Analyses

Ka Statistics	
n	*25*
Geom. Mean	1560.74
Mean	1696.95
Standard Error	142.40
Median	1520.18
Standard Deviation	712.00
Sample Variance	506937.39
Kurtosis	-0.39
Skewness	0.73
Range	2505.89
Minimum	668.50
Maximum	3174.39
Sum	42423.82

Appendix 6 - Regression statistics comparing lab and minipermeameter Ka values

Minipermeameter Ka versus Laboratory Ka

Regression Statistics	
Multiple R	0.9704
R Square	0.9416
Adjusted R Square	0.9399
Standard Error	239.56
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	31450941.0	31450941.0	548.0	1.5005E-22
Residual	34	1951184.6	57387.8		
Total	35	33402125.6			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-29.45	65.5577	-0.4492	0.6562
Slope	1.0704	0.0457	23.4103	1.5005E-22

	Lower 95%	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-162.67	103.78	-162.67	103.78
Slope	0.9775	1.1633	0.9775	1.1633

Obs. #	*Predicted Y*	*Residuals*
1	2777.2	22.5
2	3387.3	-213.0
3	2480.7	613.2
4	1259.3	-56.4
5	1357.8	154.9
6	672.8	27.9
7	1672.5	-284.2
8	1752.8	-441.4
9	1722.8	-384.2
10	1760.3	-152.8
11	1415.6	-197.4
12	933.9	-265.4
13	1442.4	-194.4
14	150.4	-52.5
15	56.2	56.8
16	-29.4	29.7
17	-29.4	29.7
18	-29.4	29.7
19	-29.4	29.8
20	-29.4	29.6
21	1065.6	-118.7
22	1528.0	539.1
23	1353.5	231.5
24	2205.6	381.6
25	1781.7	90.3
26	1730.3	16.4
27	2114.6	394.7
28	1269.0	251.2
29	2745.1	-191.6
30	116.1	8.1
31	-29.4	29.9
32	-29.4	29.5
33	-28.8	29.5
34	1452.0	-342.0
35	1642.6	-86.9
36	1150.2	-44.8