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## Section 4 Kālia Geographic Zone (T-198 to T-225)

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### 4.1 Overall Location

For reporting purposes for this AIS, the City Center Section 4 of the HHCTCP has been divided into 11 zones based on geographical and cultural boundaries. The Kālia Geographic Zone runs along Kona Street. It extends east from Pi'ikoi Street to the HHCTCP terminus, *mauka* of the Ala Moana Shopping Center, just west of the Ala Moana Building (Figure 195). The Kālia Zone was located within the westernmost portion of Waikīkī Ahupua'a, in a physiographic division known as the Honolulu Plain (Armstrong 1983:36). Pi'ikoi Street serves as the approximate boundary between Waikīkī Ahupua'a and Honolulu Ahupua'a.

The Kālia Zone includes 28 test excavations numbered T-198 through T-225 (note that T-215, T-216, and T-223 through T-225 were abandoned). Test excavation numbering generally proceeds from northwest to southeast. All Kālia test excavations were conducted on private lands. T-198 through T-205, T-207, T-208, T-212, T-217, T-218, and T-220 through T-222 were located along a section of Kona Street owned by General Growth Properties (GGP), within TMK 2-3-038:001. T-219 was within TMK 2-3-039:004, owned by Izuo Brothers, Ltd. T-223 through T-225 were in the Ala Moana Center parking structure, also owned by GGP, within TMK 2-3-038:006. T-215 and T-216 were within TMK 2-3-039:006, owned P. H. Hawaii Corp. T-206 was within TMK 2-3-039:013, owned by Kaanapali Kai, Inc./Sanno USA, Inc. T-209 through T-211, T-213, and T-214 were within TMK 2-3-039:011, owned by Sam House Development, LLC. These five test excavations were originally part of a previous investigation (Burke and Hammatt 2012).

### 4.2 Geography, Geology, and Land Forms

The Kālia Zone was situated along the low-lying coastal flats immediately inland of present-day Ala Moana Beach Park and was just under 600 m from the modern shoreline. Present-day elevations in the zone range from approximately 1.4 to 2.4 m amsl, with an average elevation of approximately 1.6 m along the corridor. The Kālia Zone was on a portion of the broad elevated coral reef in southern O'ahu that probably formed during the 7.5 m (Waimānalo) stand (Macdonald et al. 1983:420-421).

Native vegetation in this area was not well documented, but just prior to development in the early twentieth century it included *naupaka* (*Scaevola taccada*), *keawe* (*Prosopis pallida*), and coconut (*Cocos nucifera*). Today, virtually all vegetation was a result of landscaping efforts that favor ornamental introduced trees, shrubs, and ground cover. The average annual rainfall ranges from 684 to 710 mm (26 to 28 in) (Giambelluca et al. 2011), which would be marginal at best for non-irrigated agriculture.

According to the U.S. Department of Agriculture National Resources Conservation Service Soil Survey Geographic (SSURGO) Database (2001) and soil survey data gathered by Foote et al. (1972), soils within the Kālia Zone consist entirely of Fill Land (FL) (Figure 195). Fill Land soils were described as follows:

...areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.... This land type was used for urban development including airports, housing areas, and industrial facilities [Foote et al. 1972:31].

### 4.3 Modern land Use and Built Environment

The Kālia Zone traverses a commercial urban environment, following along Kona Street. Parcels *mauka* of Kona Street contain various businesses and high-rise buildings. The Ala Moana Center parking complex lies *makai* of the corridor. The transit terminates just west of the Ala Moana Building. A massive utility corridor was present throughout the Kālia Zone containing electrical, gas, water, sewer, and storm lines. The number and distribution of these existing utilities indicate that this Kālia Zone portion of Kona Street has been heavily disturbed in the past.

### 4.4 GPR Sediment Summary

Test excavations in the Kālia Geographic Zone (Zone 10) revealed that the area was predominantly Fill Lands (FL) as predicted by the U.S.G.S. Soil survey map of the zone (Figure 195). Naturally deposited sediments encountered in this zone were generally too deep for the GPR to clearly read. The average depth of clean signal return for this area was approximately one m. The only naturally deposited sediment observed in Zone 10 within the range of clean signal return was sandy clay located in T-207. Representative signal texture profiles for Zone 10 were shown in Figure 196. Signal texture profiles were only collected if the signal return was clear and the stratum was at least 0.25 m thick.

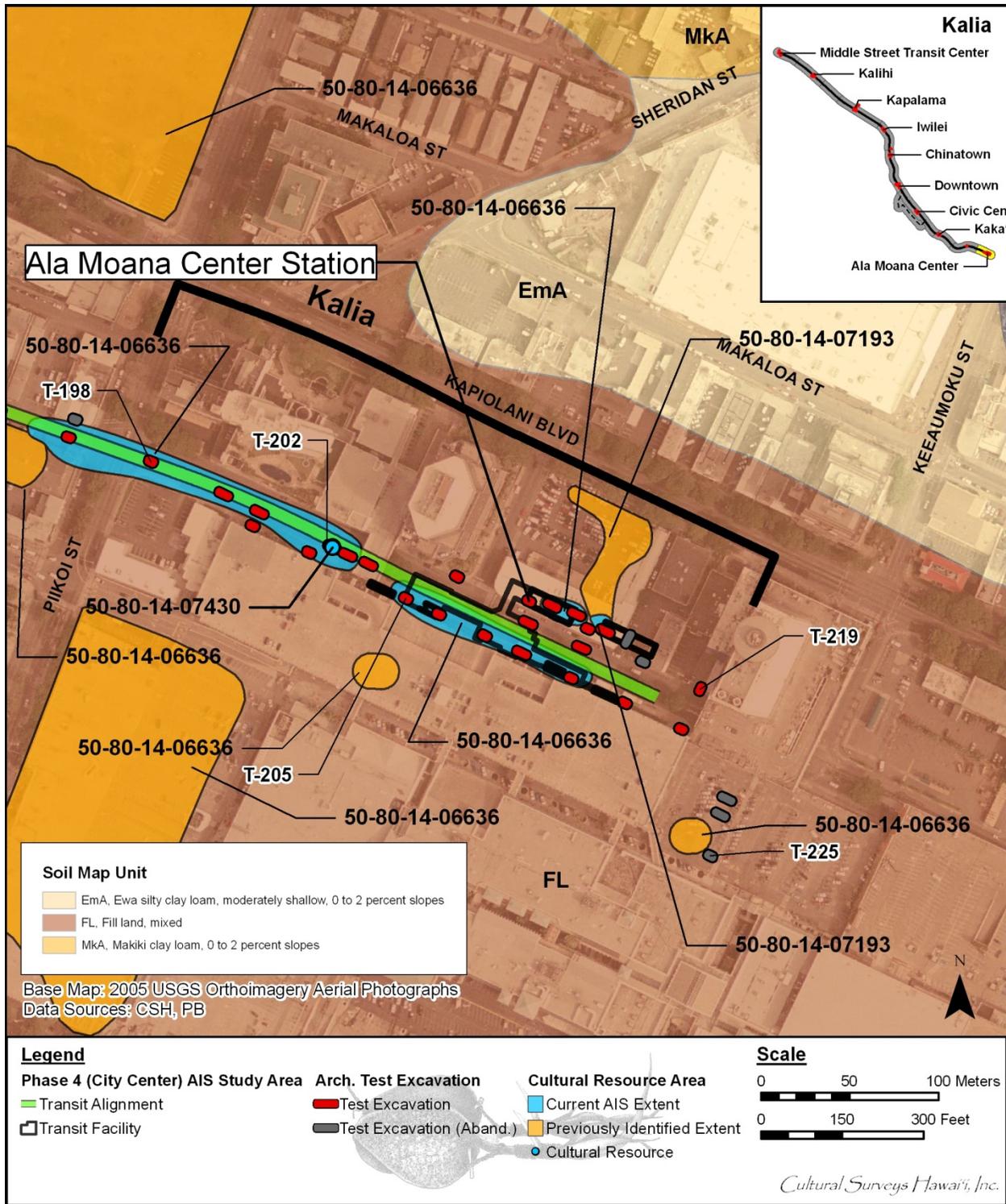


Figure 195. Aerial photograph (source: U.S. Geological Survey Orthoimagery 2005) with overlay of the Soil Survey of Hawai'i (Foote et al. 1972) showing sediment types within and in the vicinity of the Kalia Zone

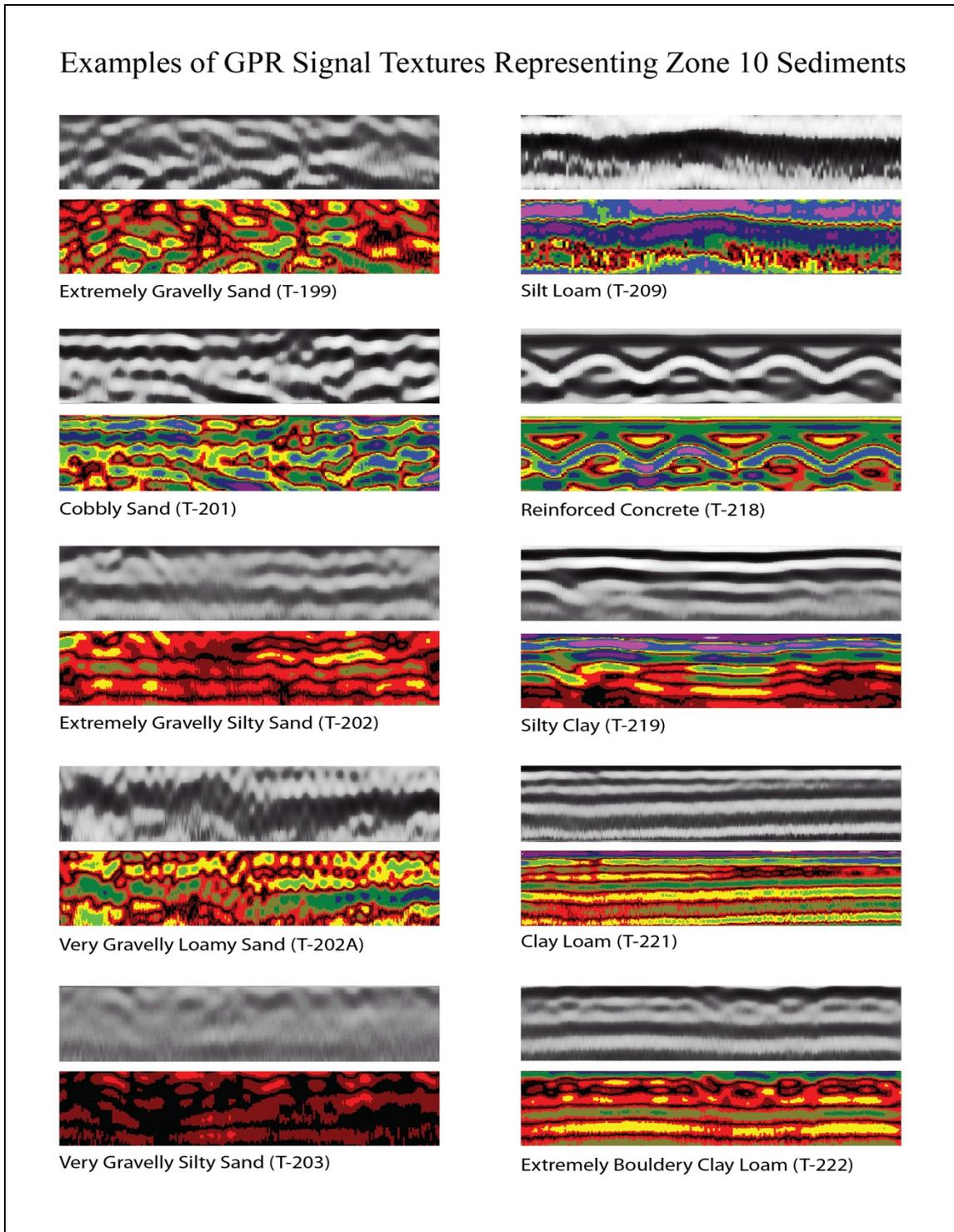


Figure 196. Examples of GPR signal textures representing Zone 10 sediments

## Test Excavation 198

T-198 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the median on Kona Street, 10 m east of Piikoi Street and Kona Street intersection. The GPR grid measured 3 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 0.3 m northeast, electrical line 2 m west, water drain 3.2 m northeast. T-198 was slightly shortened to avoid the water utility box on the southeast end.

A review of amplitude slice maps indicated an anomaly that was a water utility box in the northeastern corner of the excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except the water utility box. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 197).

GPR depth profiles for T-198 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 198). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.1 mbs. No utilities observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

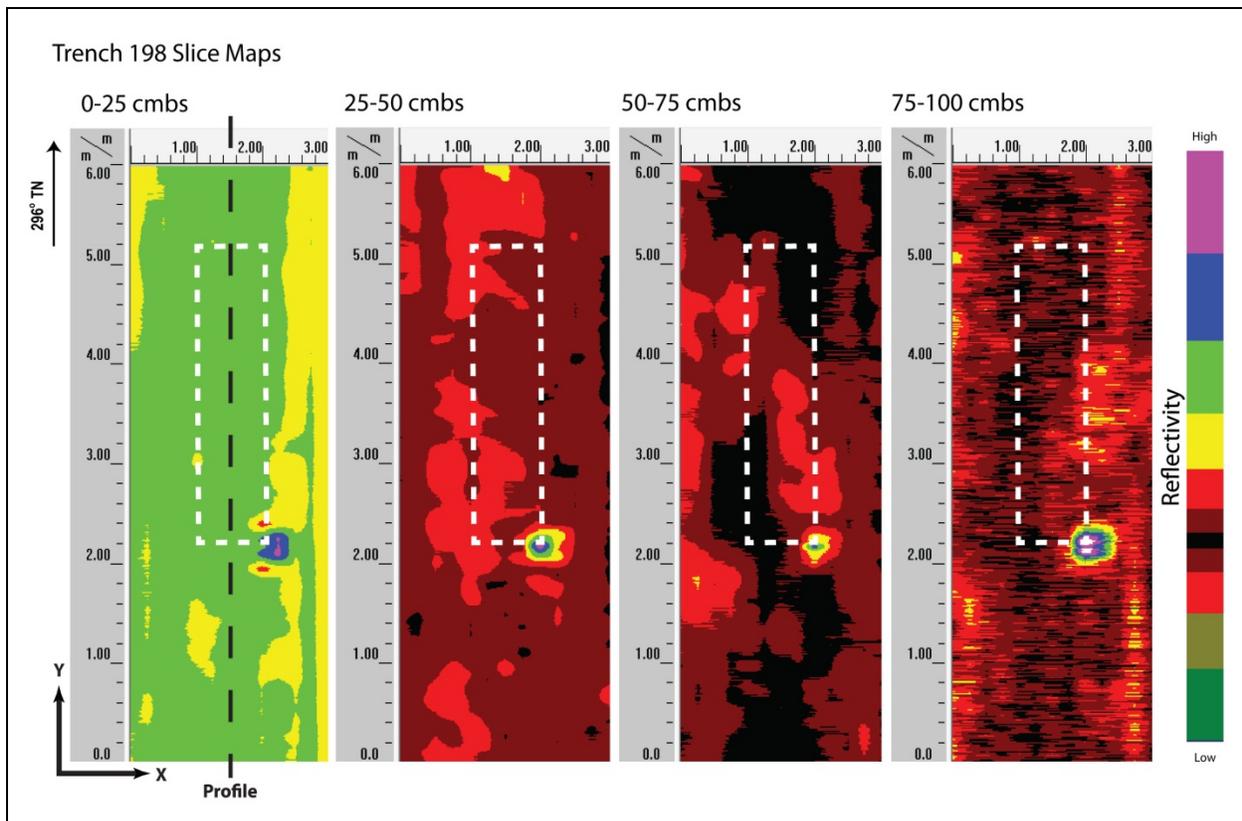


Figure 197. Slice maps of T-198 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 198). Strata Ia and Ic were clearly observed and occurred near the ground-truthed depths. Strata Ib to Id were comprised of very thin compacted layers that may be difficult to individually discern but also do not showed the horizontal banding that was typical of this configuration. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

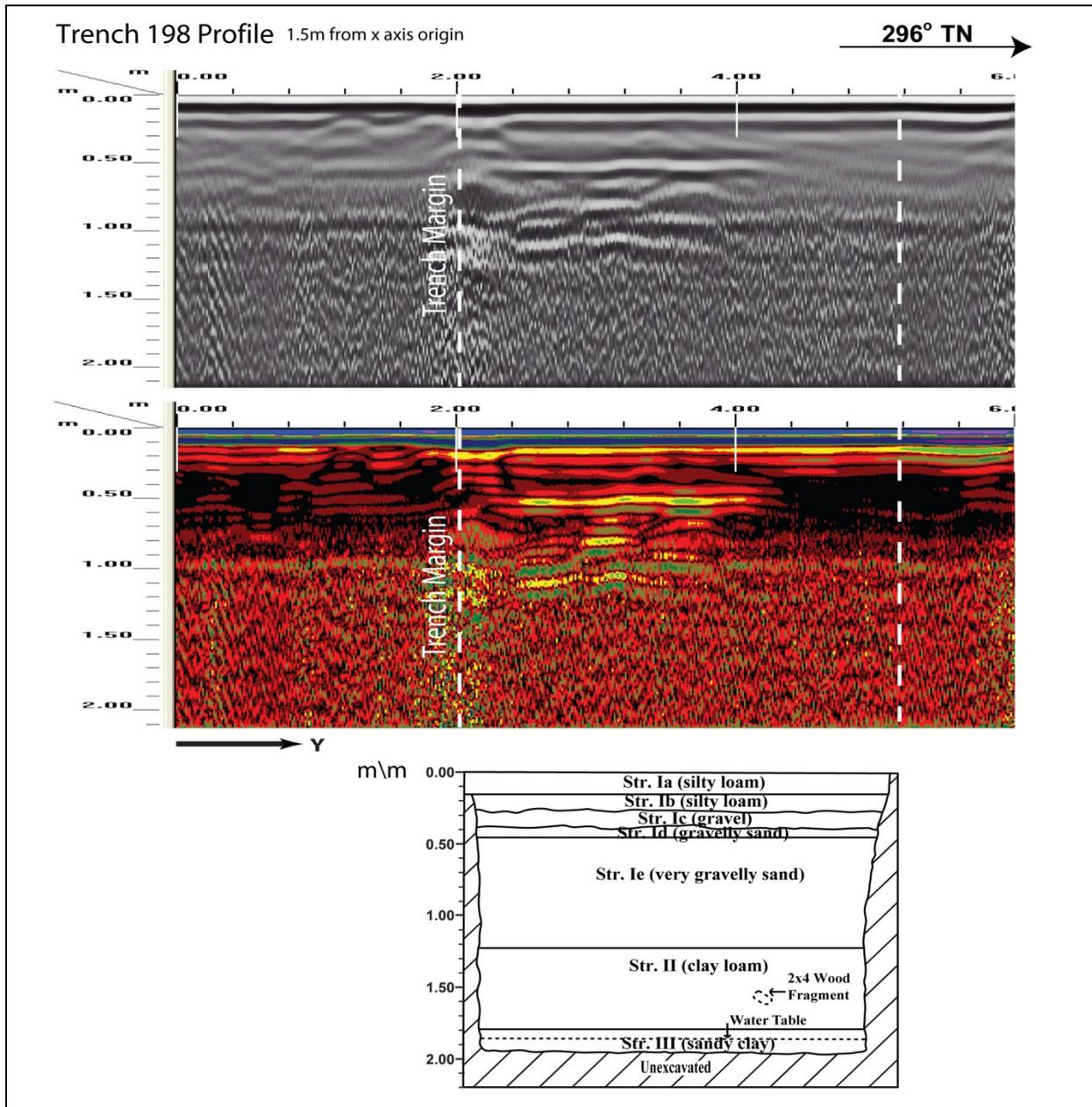


Figure 198. Visual comparison of excavated profile and GPR signal profile of T-198

## Test Excavation 199

T-199 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the median on Kona Street, 51 m southeast of Piikoi Street and Kona Street intersection. The GPR grid measured 3 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 1.5 m southwest, electrical line 2.5 m northeast. No utilities transected the excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 199).

GPR depth profiles for T-199 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 200). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.15 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.25 mbs.

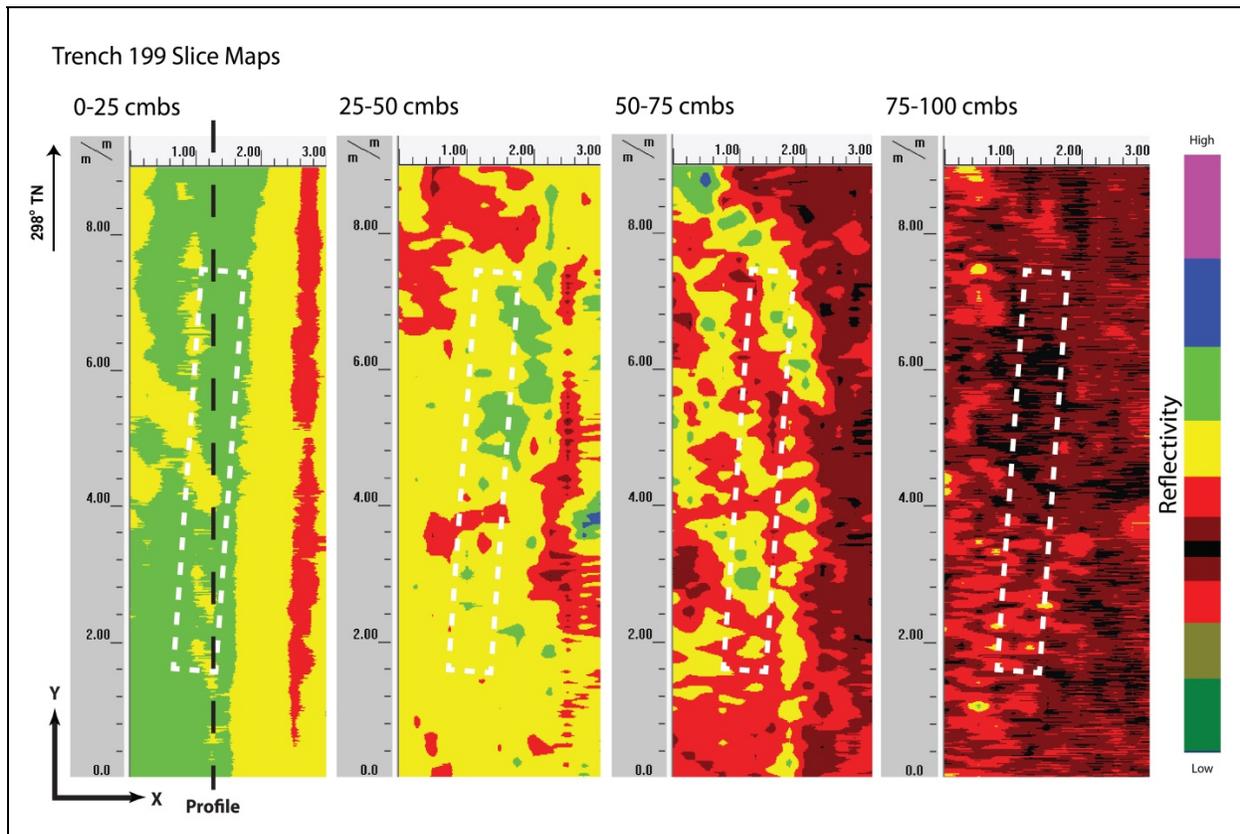


Figure 199. Slice maps of T-199 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 200). Strata Ia to Ie were clearly observed and occurred at the ground-truthed depths. Strata Ib and Id were difficult to discern because they were less than 0.05 m thick. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

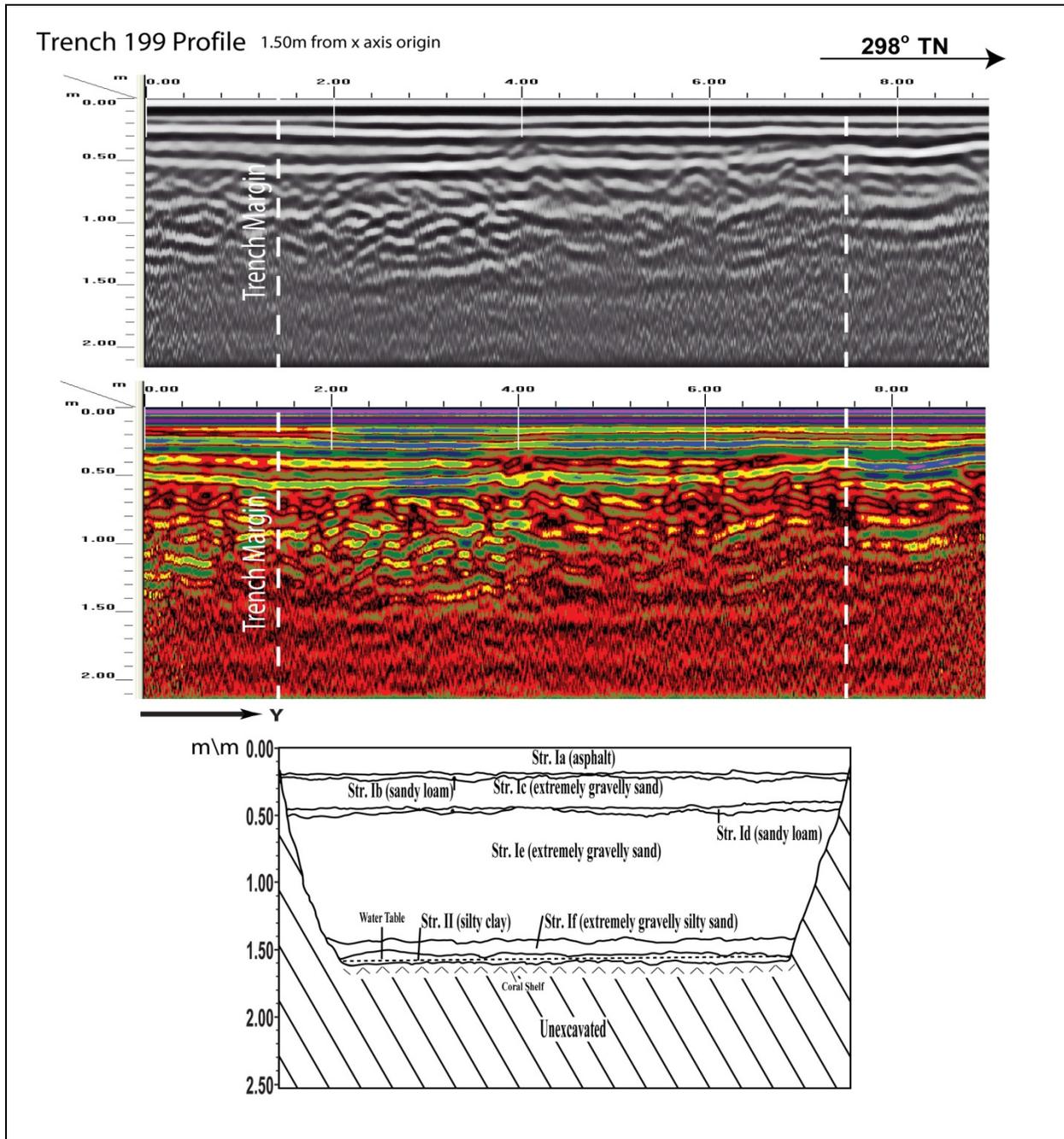


Figure 200. Visual comparison of excavated profile and GPR signal profile of T-199

## Test Excavation 200

T-200 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 80 m southeast of Kona Street and Piikoi Street intersection. The GPR grid measured 3 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 0.6 m northeast, water drain 2.8 m northeast, water line 6 m northeast.

A review of amplitude slice maps indicated a linear feature but was not encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 201).

GPR depth profiles for T-200 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 202). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.4 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.9 mbs.

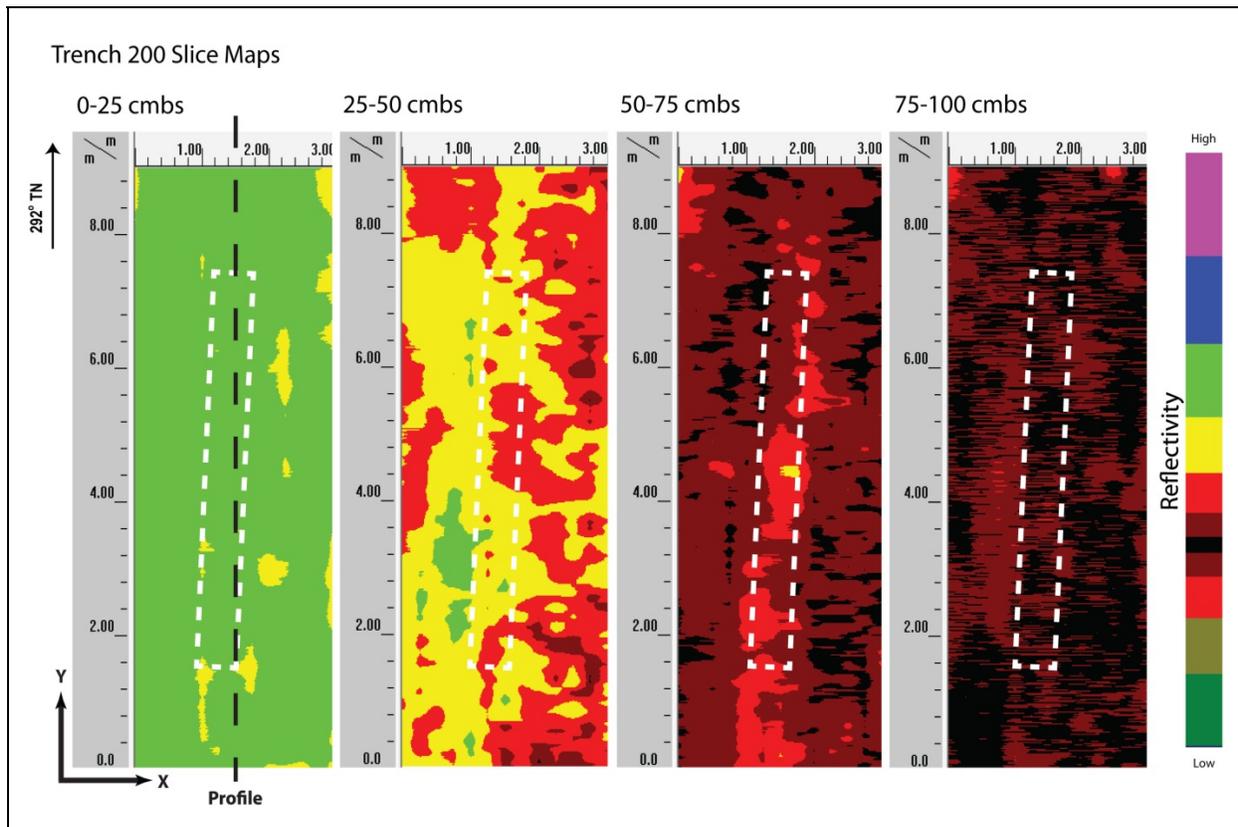


Figure 201. Slice maps of T-200 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 202). Strata Ia to If were clearly observed and occurred at the ground-truthed depths. Strata Ib through Ie were difficult to individually discern, possibly due to the fact that they were very thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

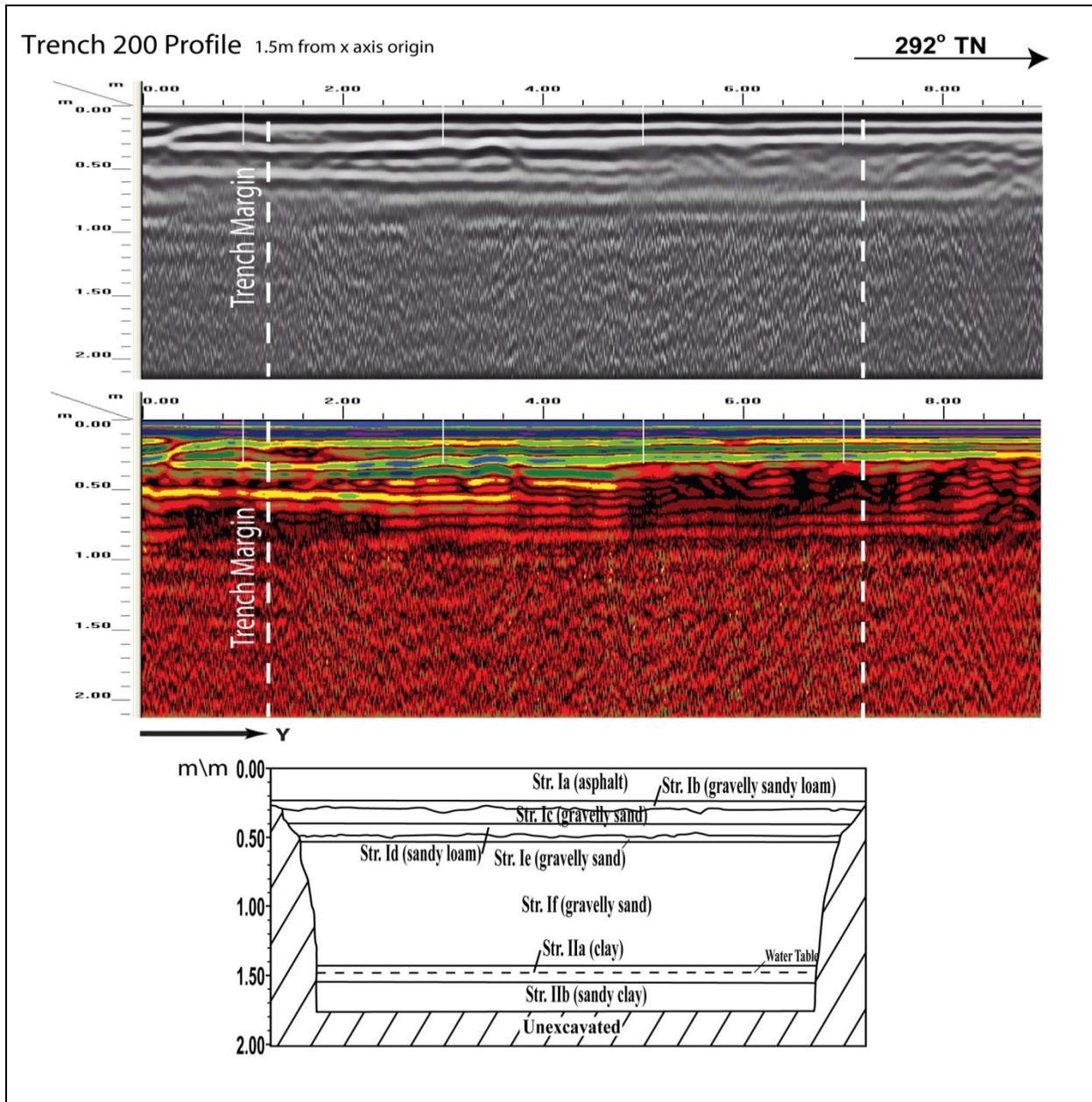


Figure 202. Visual comparison of excavated profile and GPR signal profile of T-200

## Test Excavation 201

T-201 measured 1 m by 4 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 80 m southeast of Kona Street and Piikoi Street. The GPR grid measured 2 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 9 m northeast. No utilities transected the excavation location.

A review of amplitude slice maps indicated a linear feature but was not encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the linear feature. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 203).

GPR depth profiles for T-201 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 204). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.35 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

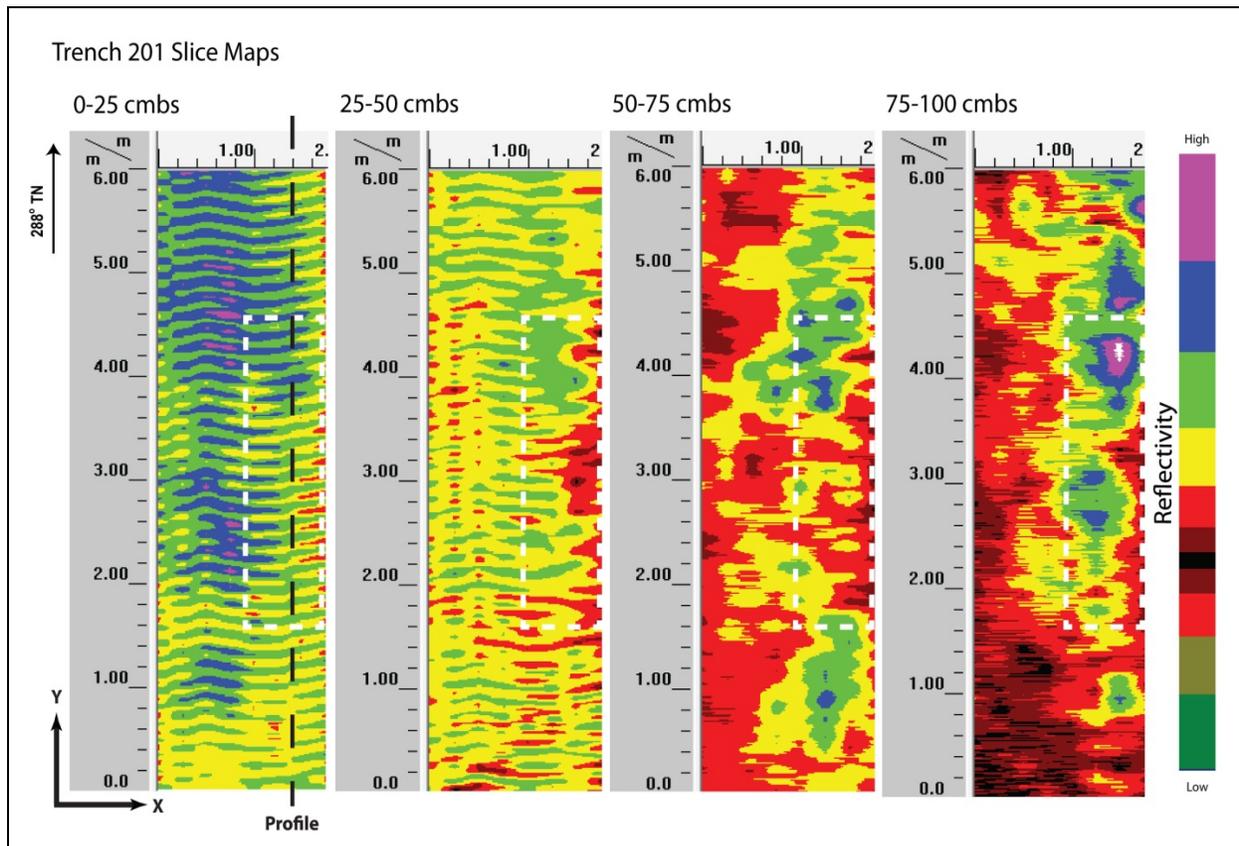


Figure 203. Slice maps of T-201 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a weak correlation in stratigraphic transitions (Figure 204). Strata included, from top to bottom, concrete, sand fill, asphalt, base course, sandy loam fill, cobbly sand fill, sandy loam fill, gravelly sand fill, and cobbly sand fill. These transitions were not clearly depicted in the GPR profile at the depths that they occurred. No other sediment transitions or discrete objects were observed in the GPR results or subsequent excavation.

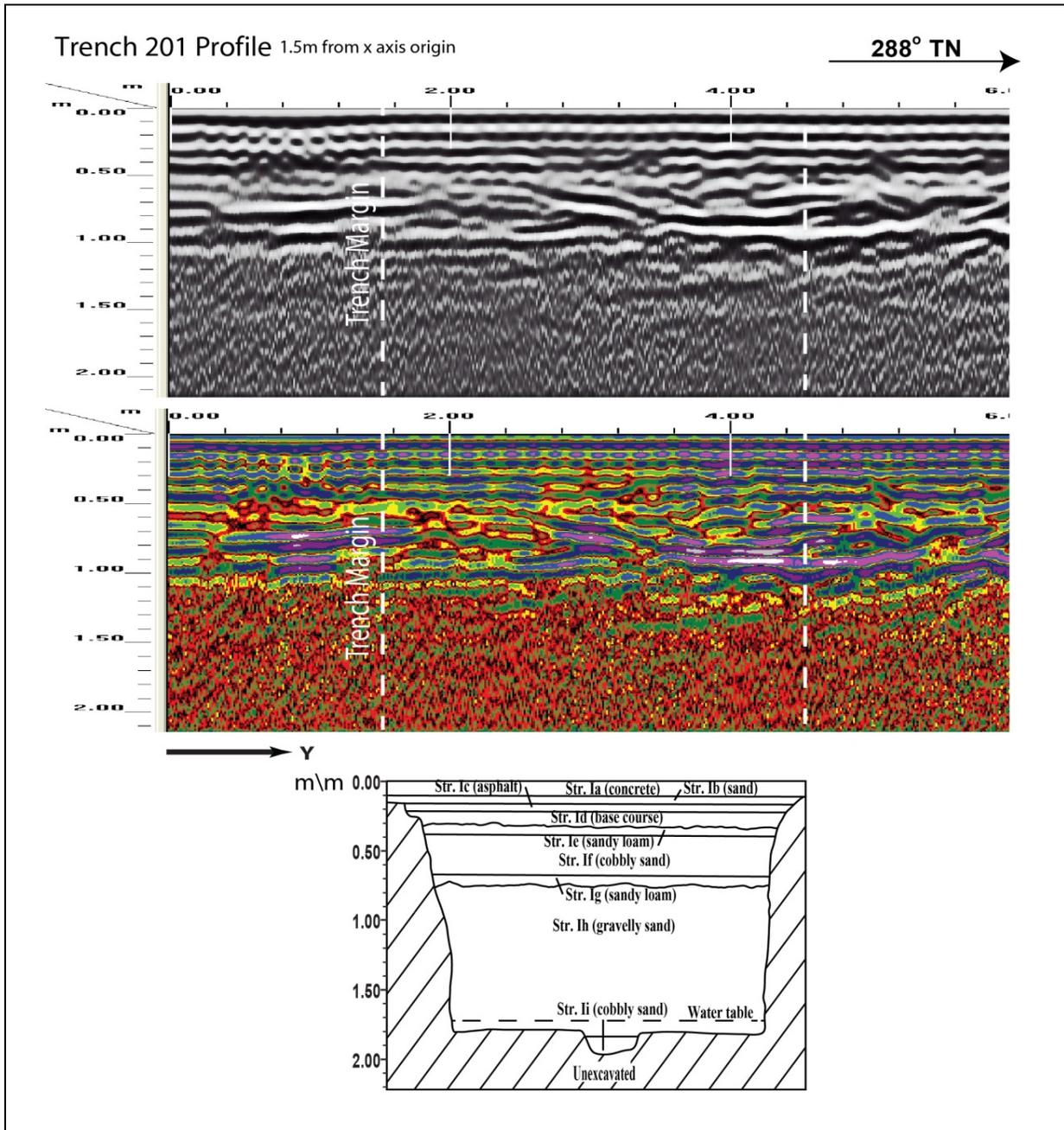


Figure 204. Visual comparison of excavated profile and GPR signal profile of T-201

## Test Excavation 202

T-202 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 80 m northwest of Kona Street and Kona Iki street intersection. The GPR grid measured 3 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water drain 3.1 m northeast, water line 4.2 m east. No utilities transected the excavation location.

A review of amplitude slice maps indicated a linear feature but not within excavation boundaries. Reflectivity was relatively uniform throughout the grid and decreased with depth except the linear feature. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 205).

GPR depth profiles for T-202 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 206). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.2 mbs. An anomaly was observed in the profile but was not within excavation boundaries. The maximum depth of clean signal return was approximately 1.0 mbs.

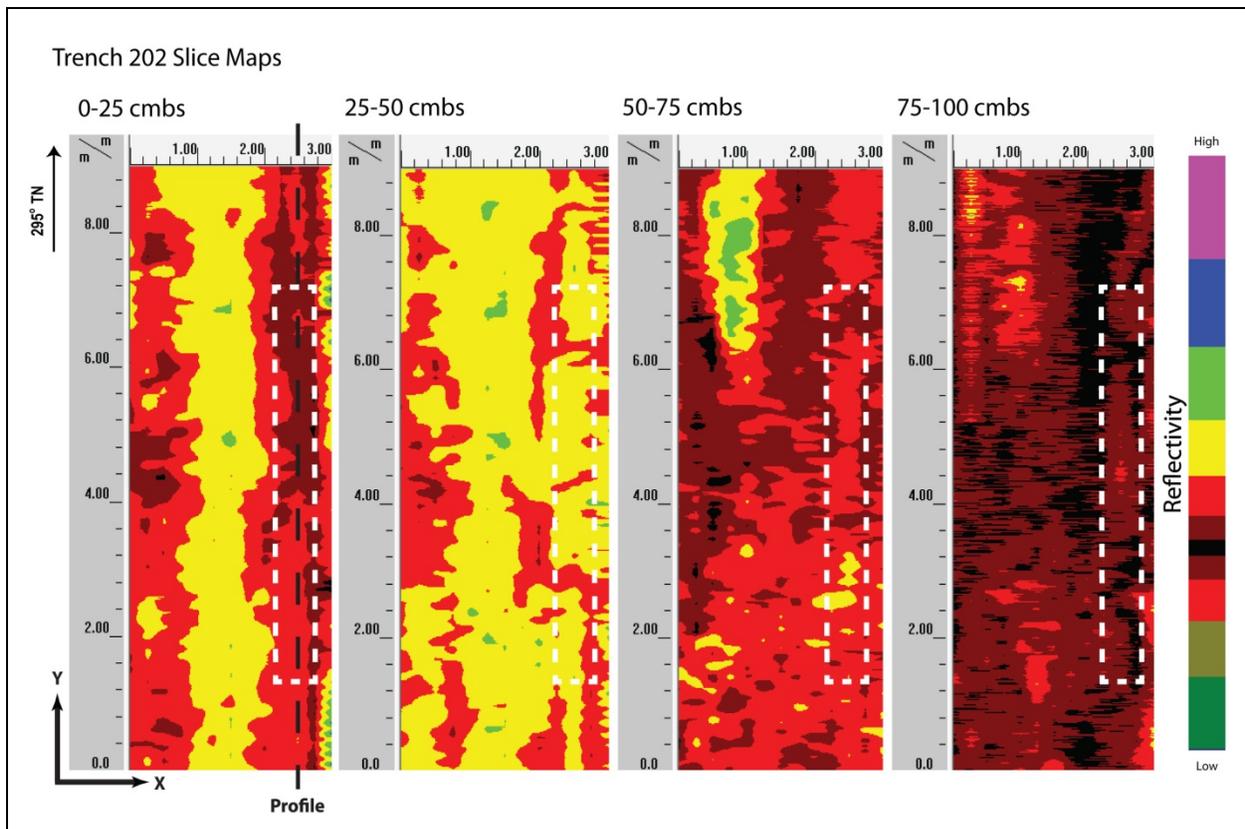


Figure 205. Slice maps of T-202 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 206). Strata Ia to Ie were clearly observed and occurred at the ground-truthed depths. Strata included, from top to bottom, concrete, gravelly sandy clay loam fill, extremely gravelly silty sand fill, extremely gravelly silty sand fill, sandy clay fill, extremely gravelly clay fill, and natural silty clay. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

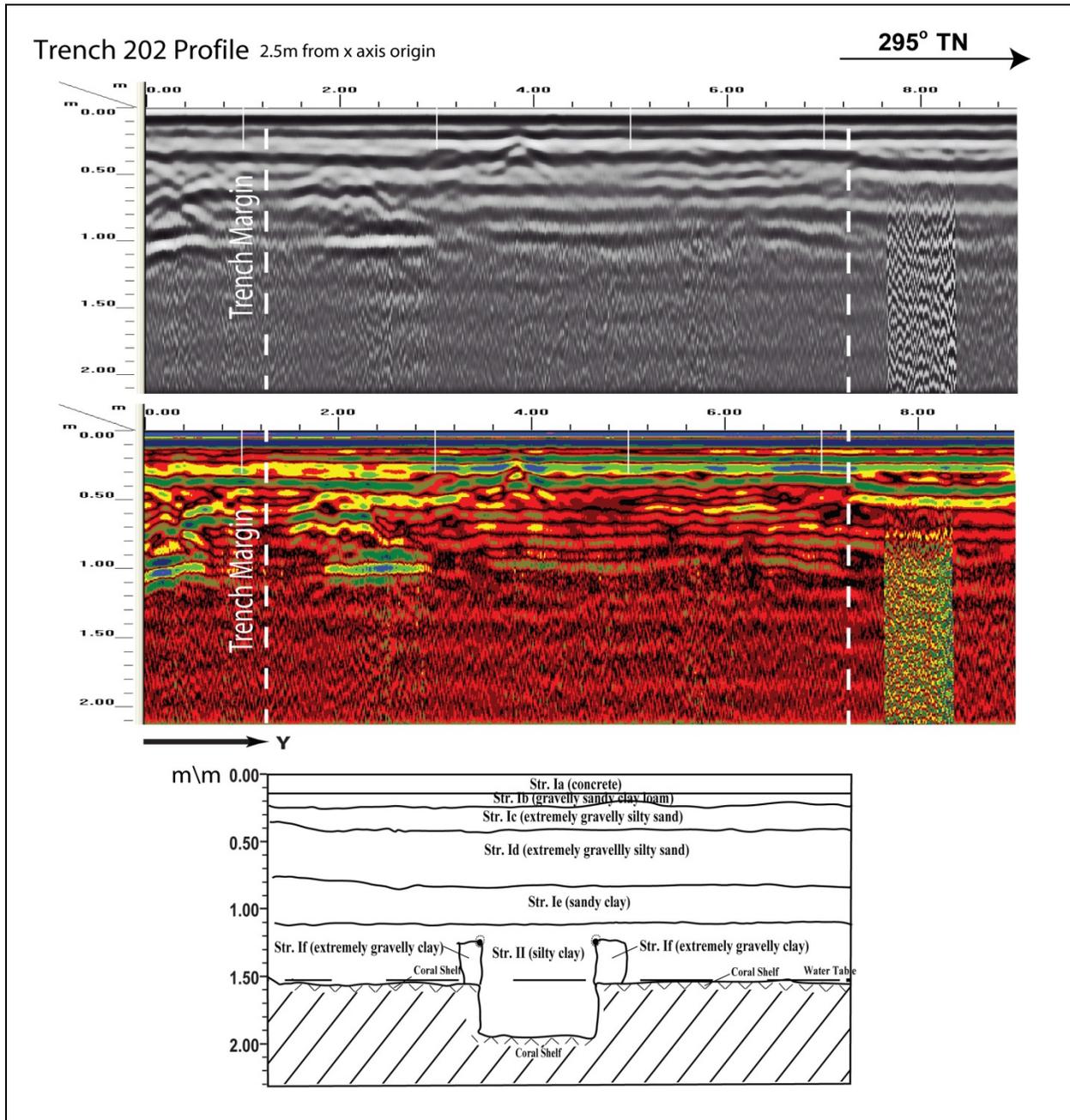


Figure 206. Visual comparison of excavated profile and GPR signal profile of T-202

## Test Excavation 202A

T-202A measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 70 m northwest of Kona Street and Kona Iki Street intersection. The GPR grid measured 3 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 2 m northeast, water drain 3.4 m northeast. No utilities transected the excavation location.

A review of amplitude slice maps indicated linear features but none were encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the feature in the western corner. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.50 mbs (Figure 207).

GPR depth profiles for T-202A identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 208). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.35 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

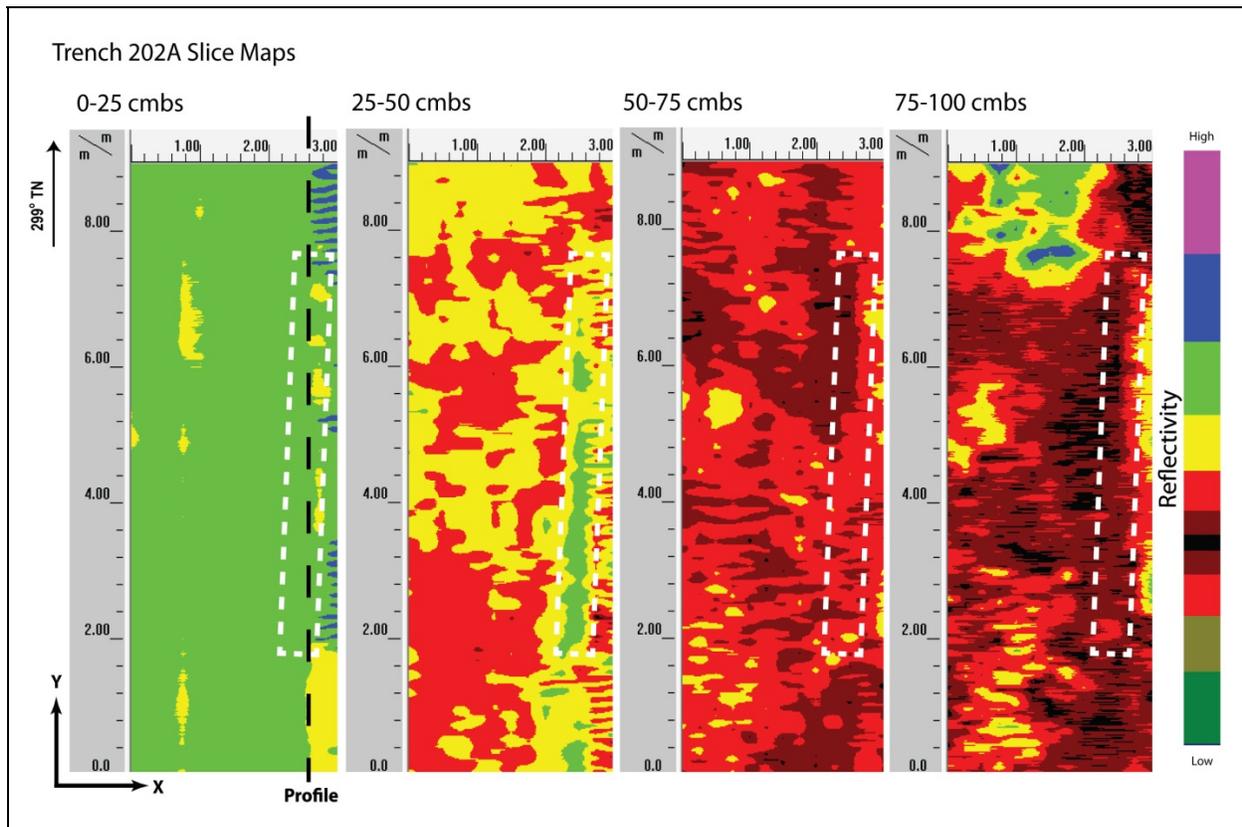


Figure 207. Slice maps of T-202A at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 208). Strata Ia and Ie were clearly observed and occurred at the ground-truthed depths. Strata Ia through Ic were difficult to individually discern, possibly due to the fact that they were thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

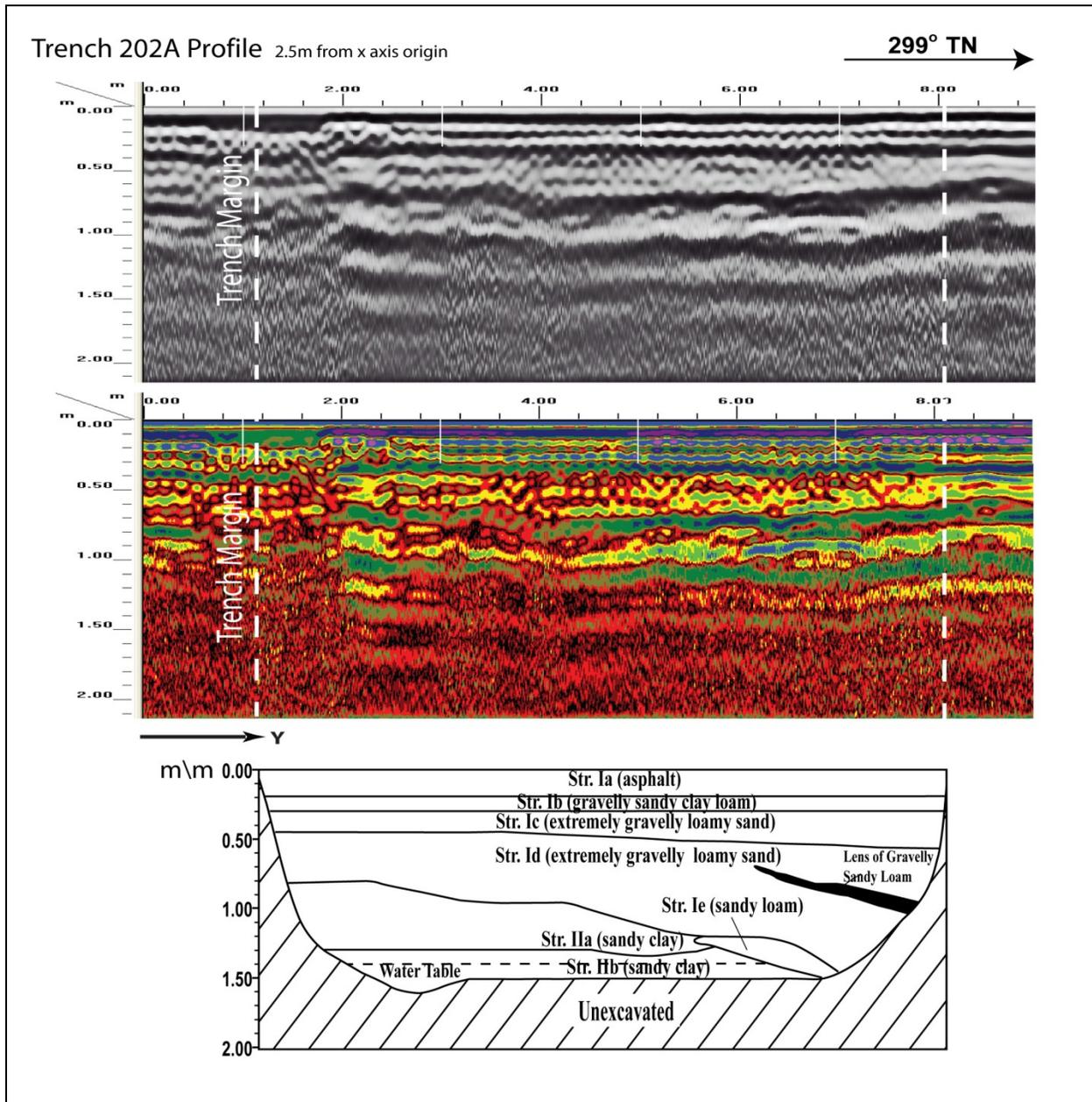


Figure 208. Visual comparison of excavated profile and GPR signal profile of T-202A

### Test Excavation 203

T-203 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 93 m northwest of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 7 m northwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 209).

GPR depth profiles for T-203 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 210). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.3 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

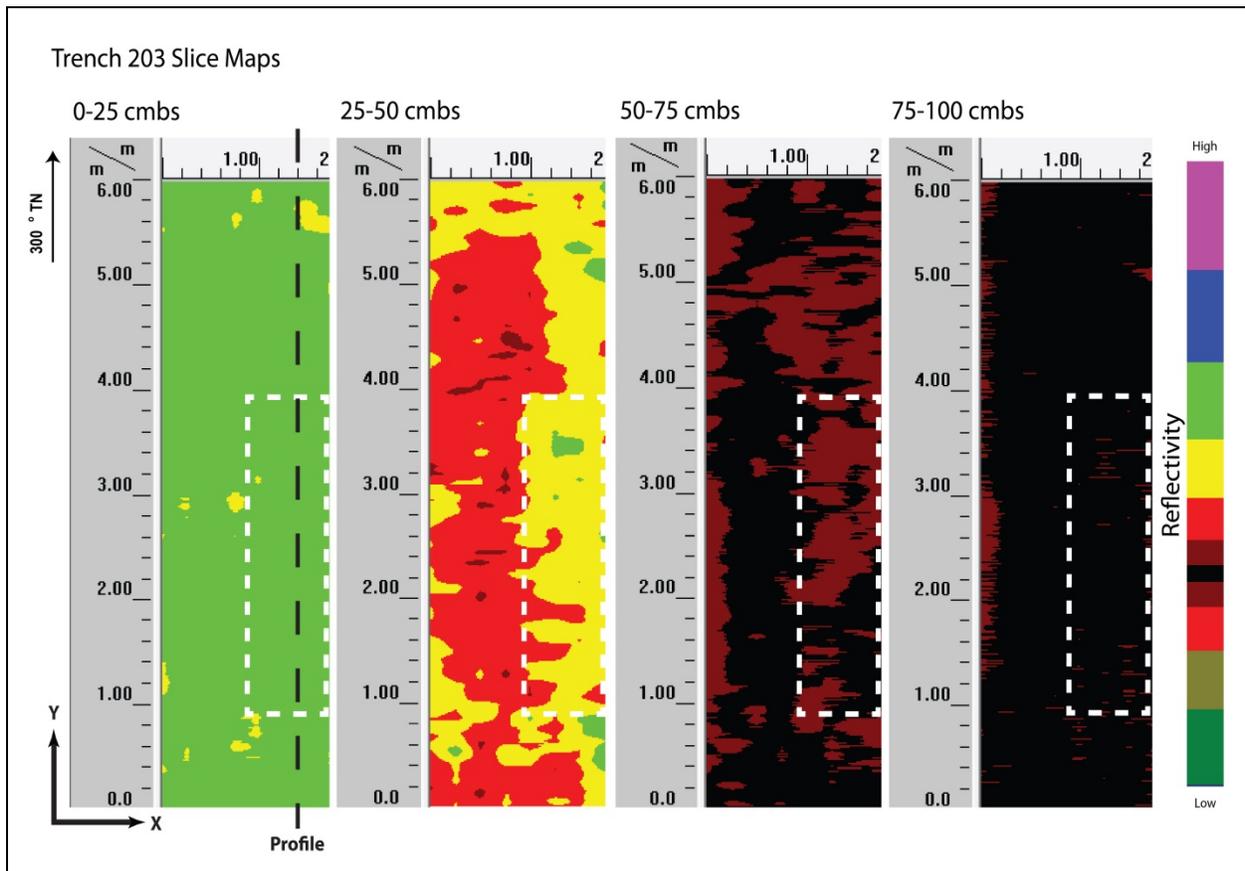


Figure 209. Slice maps of T-203 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 210). Strata Ia to If were clearly observed and occurred at the ground-truthed depths. Strata Ia through Ic may be difficult to individually discern, possibly due to the fact that they were very thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

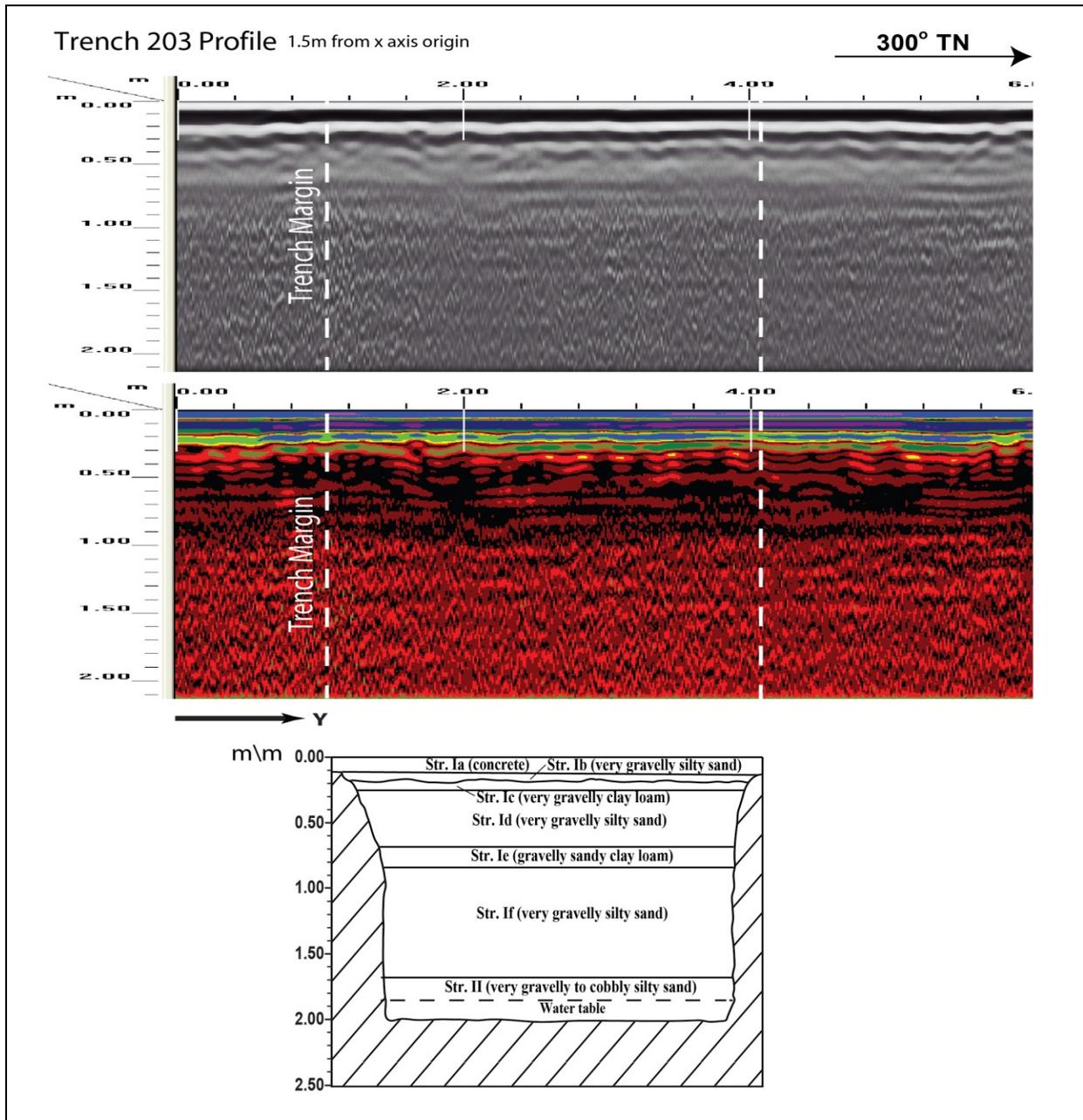


Figure 210. Visual comparison of excavated profile and GPR signal profile of T-203

## Test Excavation 204

T-204 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 58 m northwest of Kona Street and Kona Iki street intersection. The GPR grid measured 3 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 1.5 m northeast, water drain 3 m northeast, electrical line 3.8 m northwest. An abandoned metal utility pipe was encountered 0.5 mbs in the center of the excavation.

A review of amplitude slice maps indicated a linear features which might corresponded to the utility pipe encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 211).

GPR depth profiles for T-204 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 212). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.2 mbs and again at approximately 0.55 mbs. No utilities were observed in the profile although a utility was encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

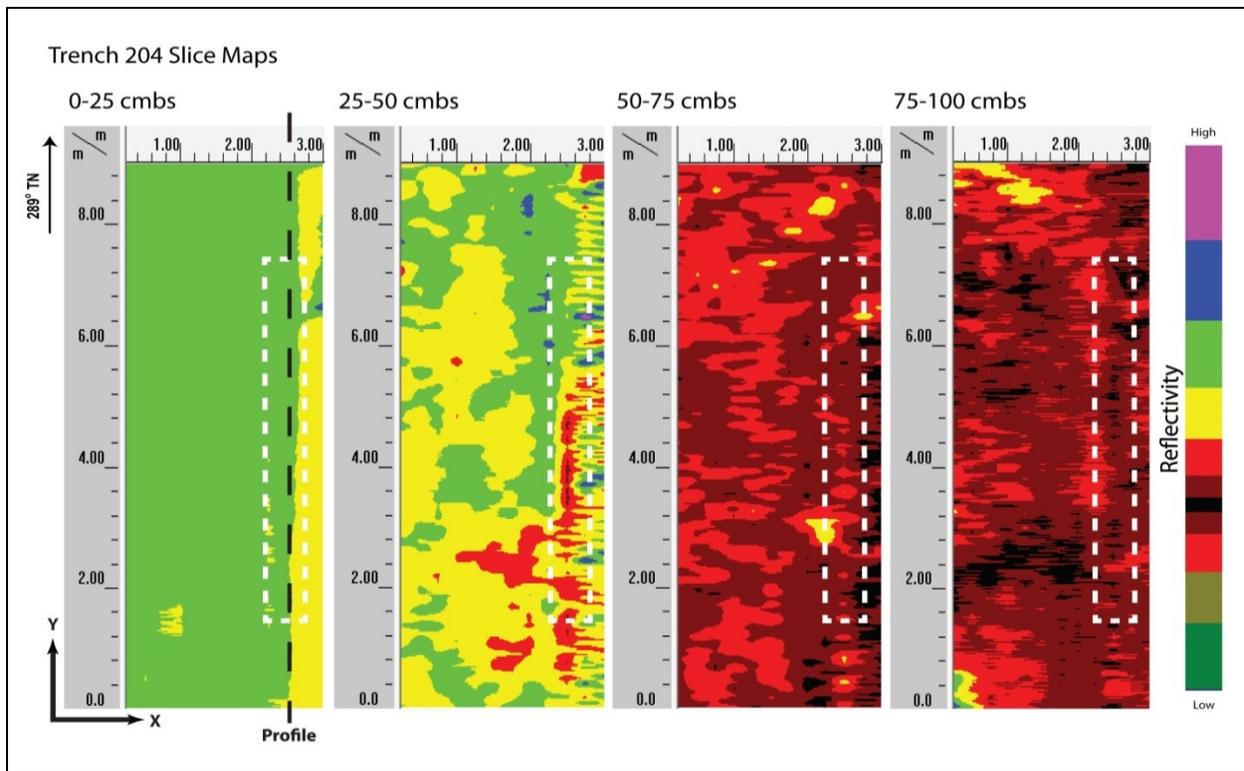


Figure 211. Slice maps of T-204 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 212). Strata Ia to Ic were clearly observed and occurred near the ground-truthed depths. Strata included a layer of asphalt on top of gravelly sandy clay loam fill followed by extremely gravelly silty sand fill. A metal utility was found 0.5 mbs. This pipe did not show up on the profile or slice maps. This may be due to the fact that the pipe was empty. No other discrete objects or stratigraphic transitions were observed in the GPR results or subsequent excavation.

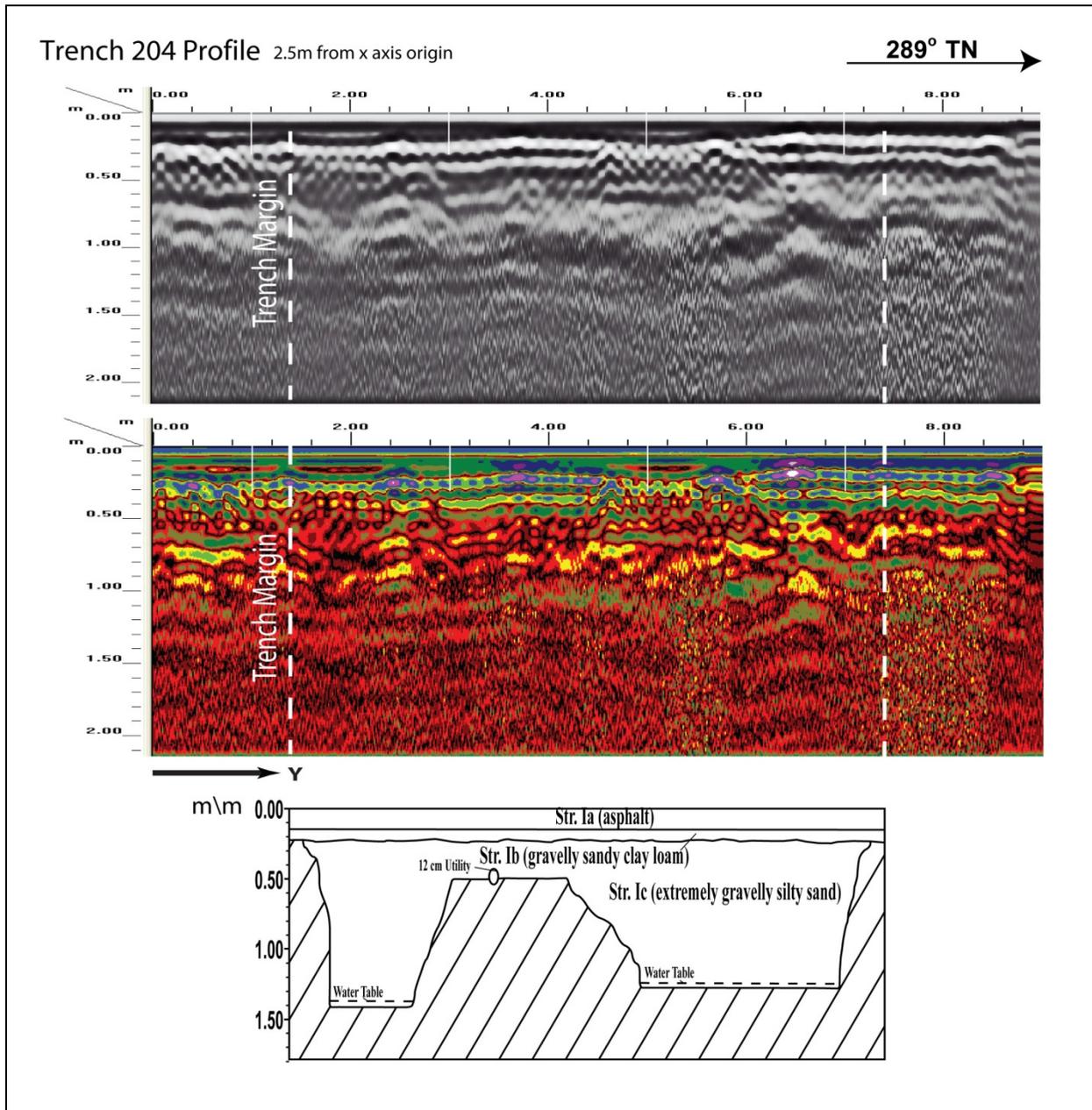


Figure 212. Visual comparison of excavated profile and GPR signal profile of T-204

## Test Excavation 205

T-205 measured 0.9 m by 3 m and was oriented northwest to southeast, and was located within the sidewalk on Kona Street, 35 m west of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities within close proximity of the excavation. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 213).

GPR depth profiles for T-205 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 214). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.25 mbs. An anomaly was present however it was not within excavation boundaries. No utilities were observed in the excavation unit. The maximum depth of clean signal return was approximately 1.0 mbs.

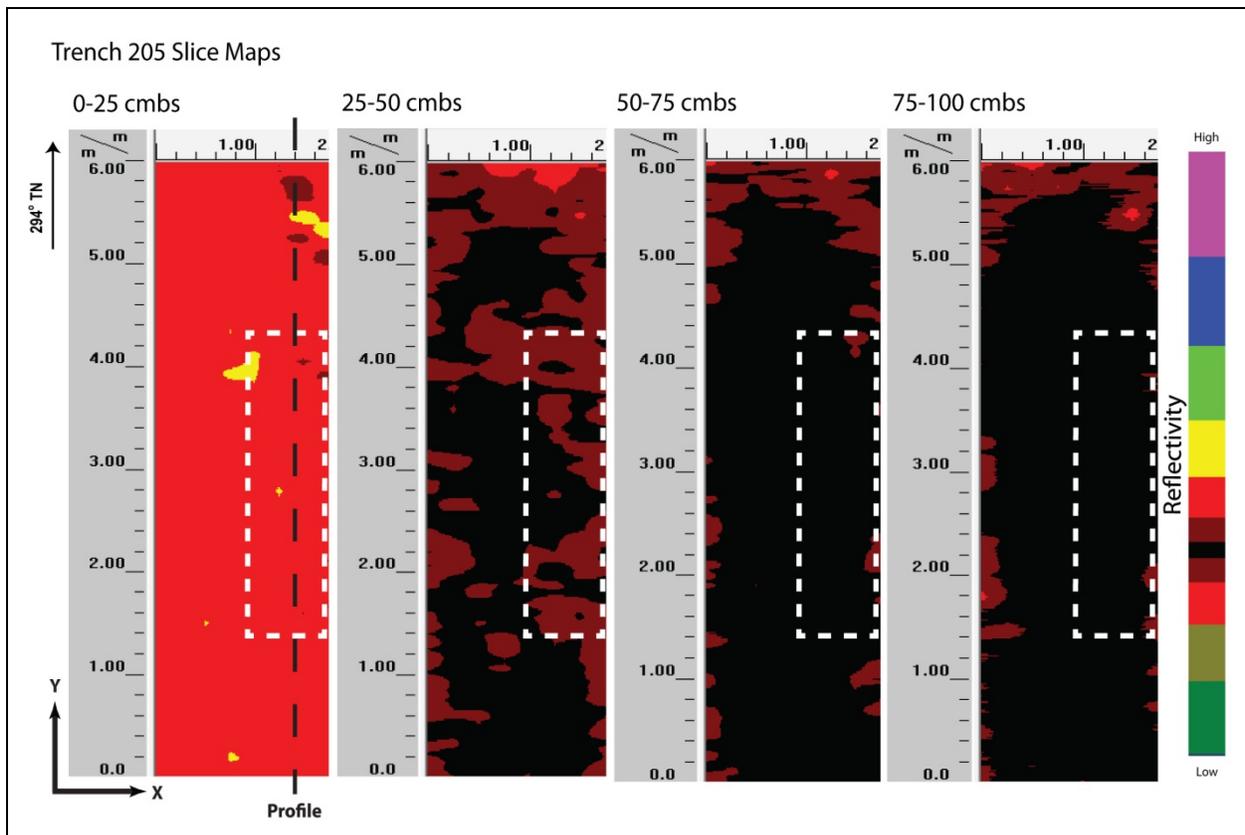


Figure 213. Slice maps of T-205 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 214). Strata Ia and Ib were clearly observed and occurred near the ground-truthed depths. Strata included, from top to bottom, concrete, gravelly sandy clay loam fill, very gravelly silty sand fill, very gravelly to cobbly silty sand fill, and natural silty clay. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

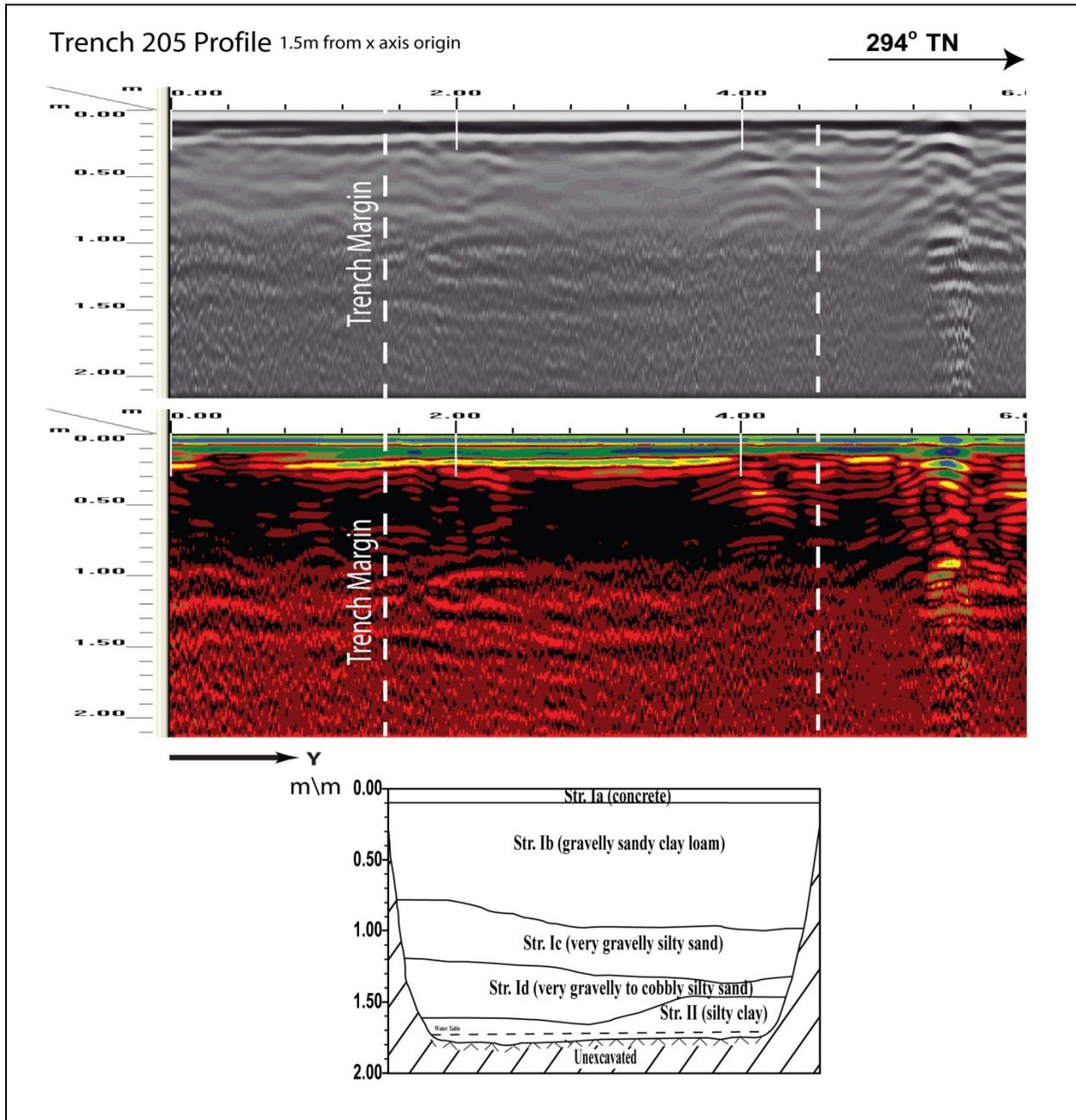


Figure 214. Visual comparison of excavated profile and GPR signal profile of T-205

## Test Excavation 207

T-207 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 15 m north of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 0.9 m southwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 215).

GPR depth profiles for T-207 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 216). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.3 mbs. No utilities observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

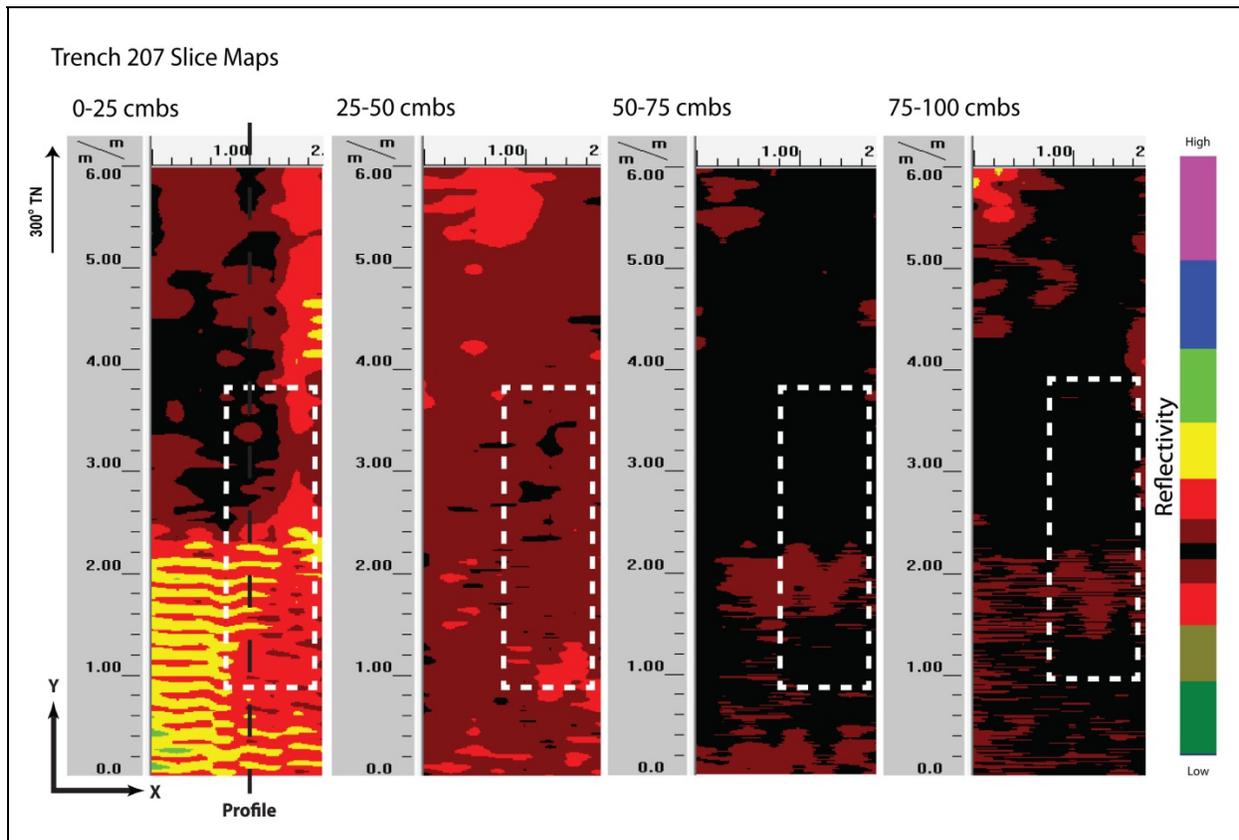


Figure 215. Slice maps of T-207 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 216). Strata Ia to IIa were clearly observed and occurred at the ground-truthed depths. Strata Ia through Ic may be difficult to individually discern, possibly due to the fact that they were very thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

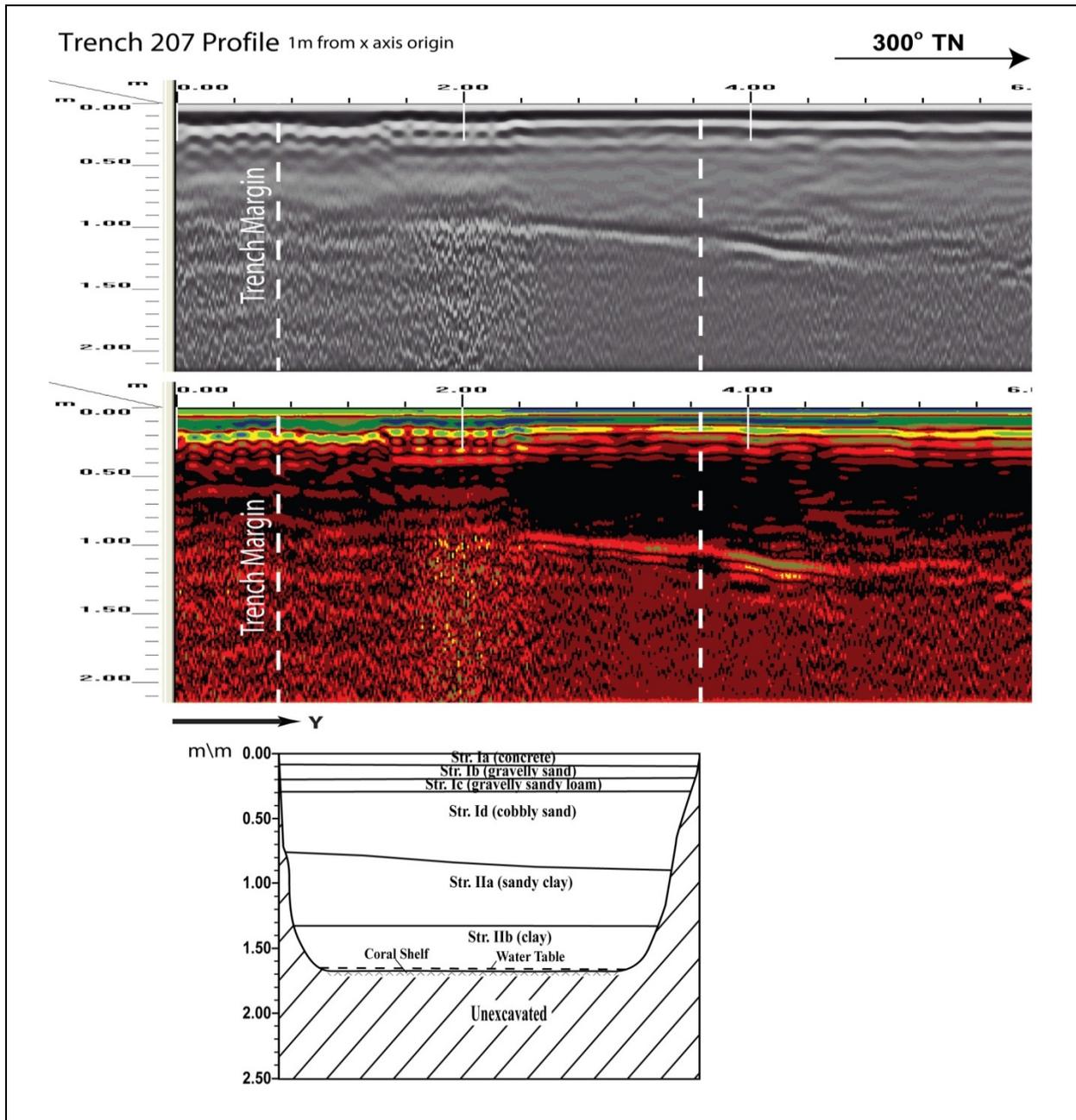


Figure 216. Visual comparison of excavated profile and GPR signal profile of T-207

## Test Excavation 208

T-208 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 15 m southeast of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 4 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities within close proximity of the excavation. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 217).

GPR depth profiles for T-208 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 218). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.55 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.9 mbs.

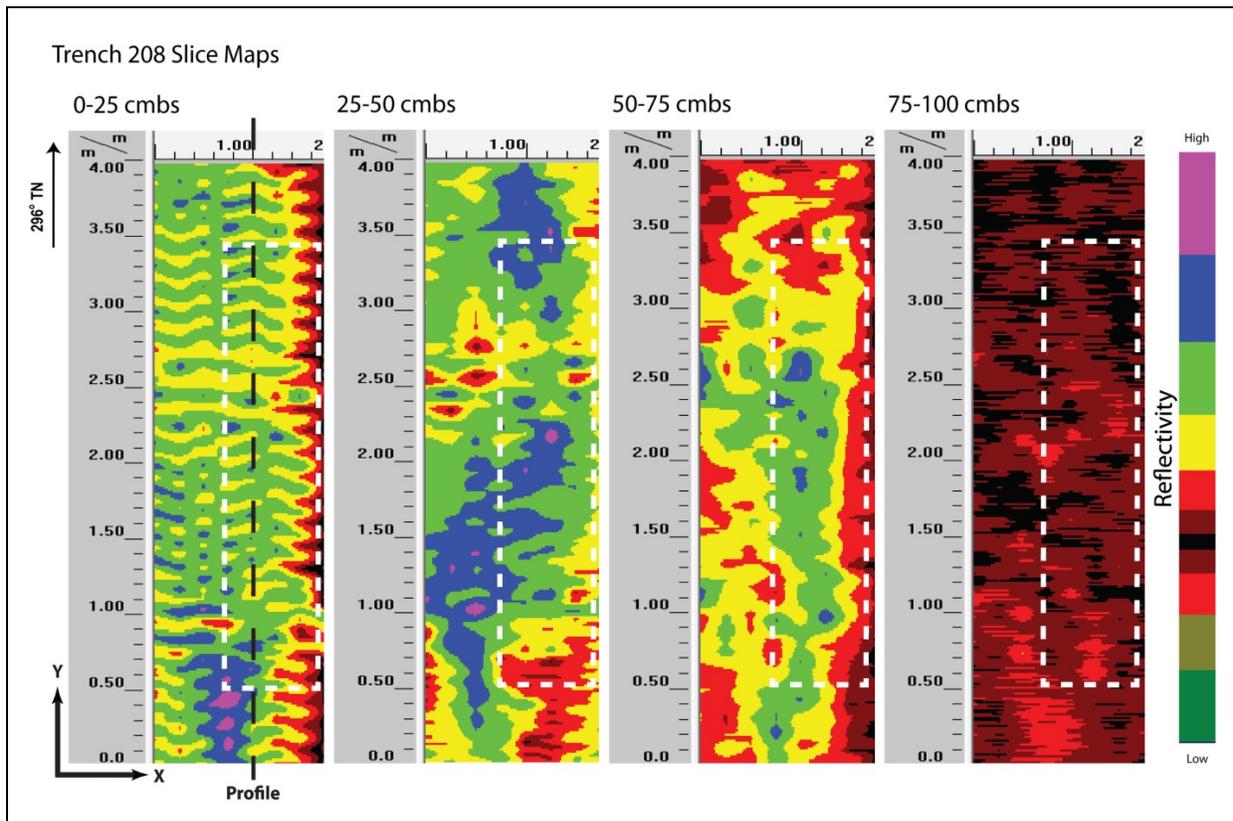


Figure 217. Slice maps of T-208 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 218). Strata Ia to Ie were clearly observed and occurred near the ground-truthed depths. Strata Ia through Id may be difficult to individually discern, possibly due to the fact that they were very thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

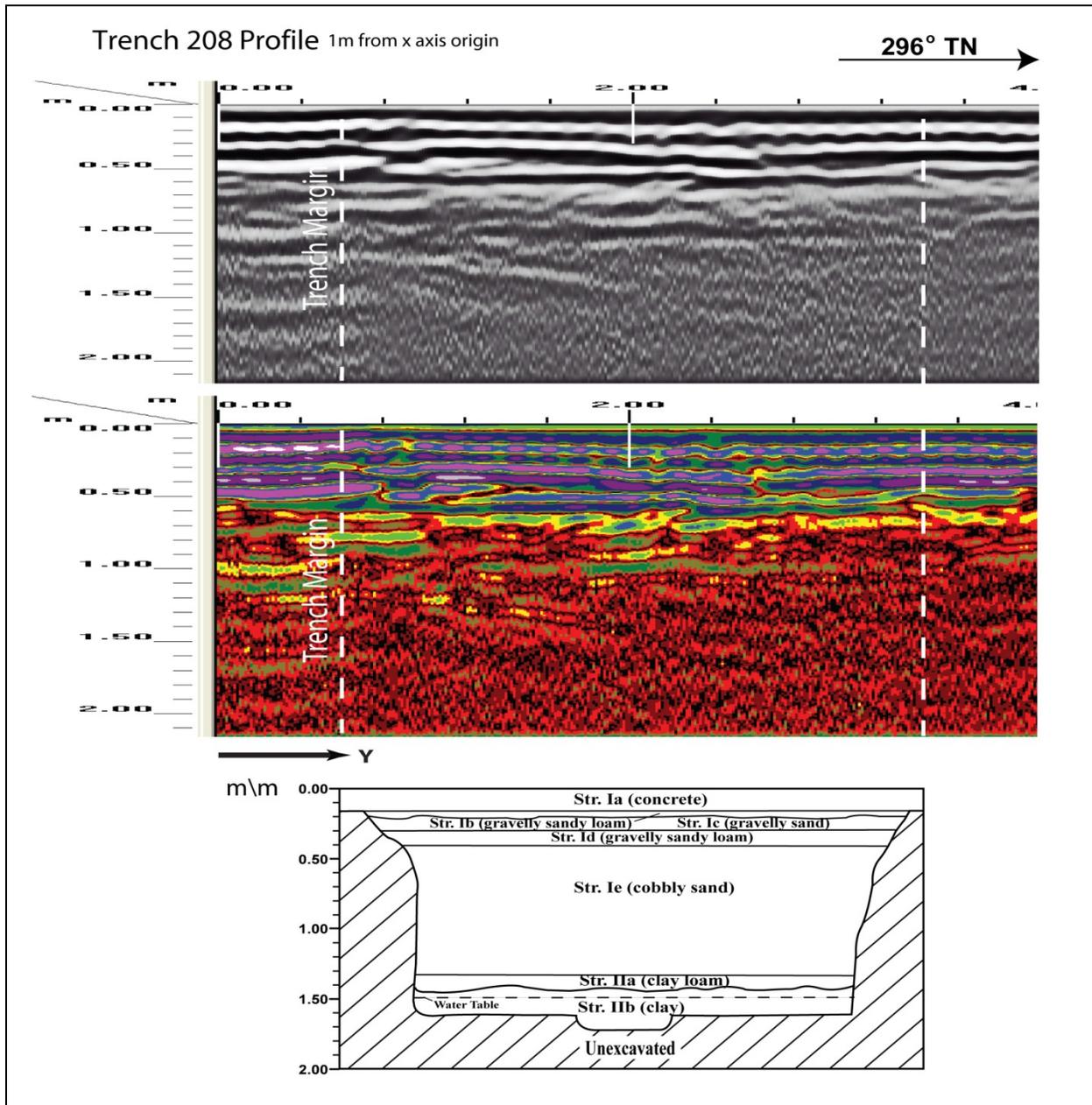


Figure 218. Visual comparison of excavated profile and GPR signal profile of T-208

## Test Excavation 209

T-209 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 15 m southeast of Kona Street and Kona Iki Street intersection. The GPR grid measured 3 m by 6 m with 50 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities within close proximity of the excavation. No utilities transected the GPR grid or the excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 219).

GPR depth profiles for T-209 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 220). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.45 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.85 mbs.

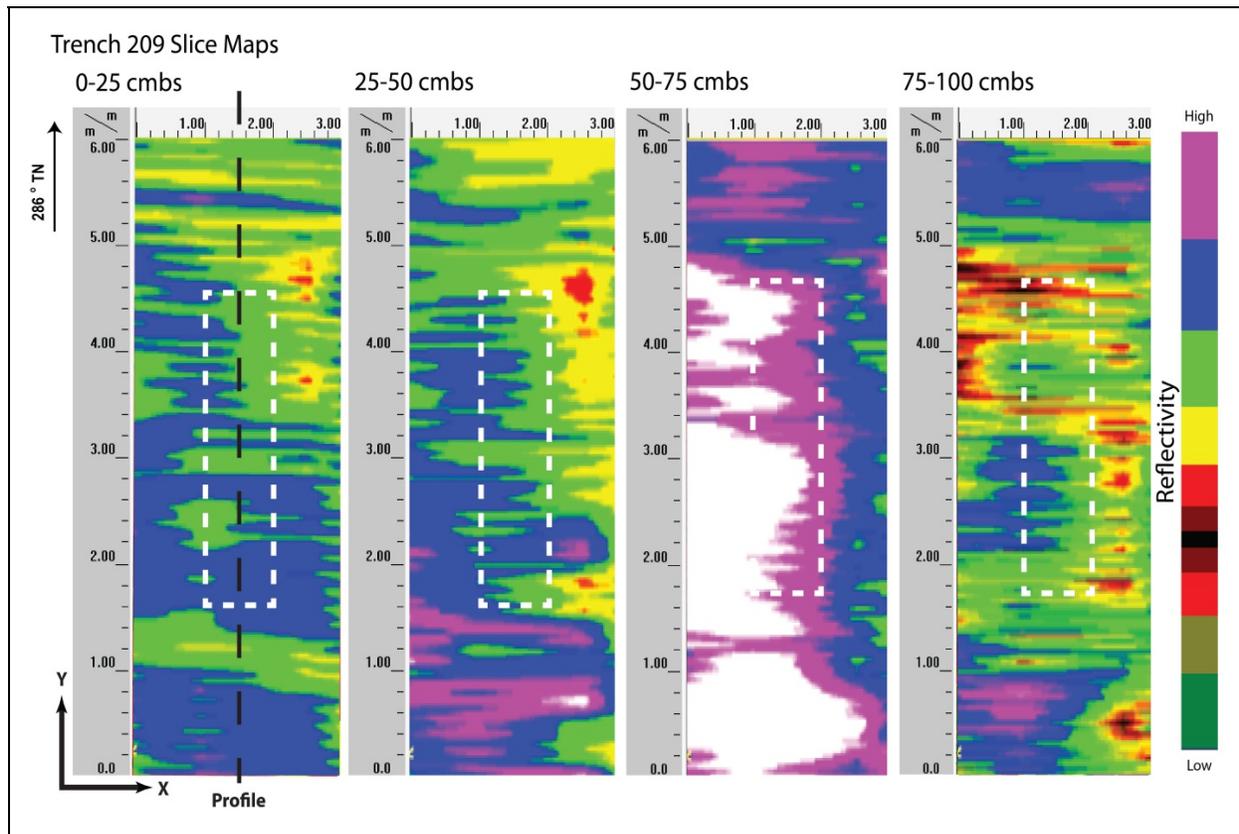


Figure 219. Slice maps of T-209 at 25 cm depth interval

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 220). Strata Ia through Ie were clearly observed and occurred at the ground-truthed depths. Strata included, from top to bottom, concrete, gravelly silt fill, asphalt, crushed coral, silt loam fill, natural silt loam, and natural clayey sand. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

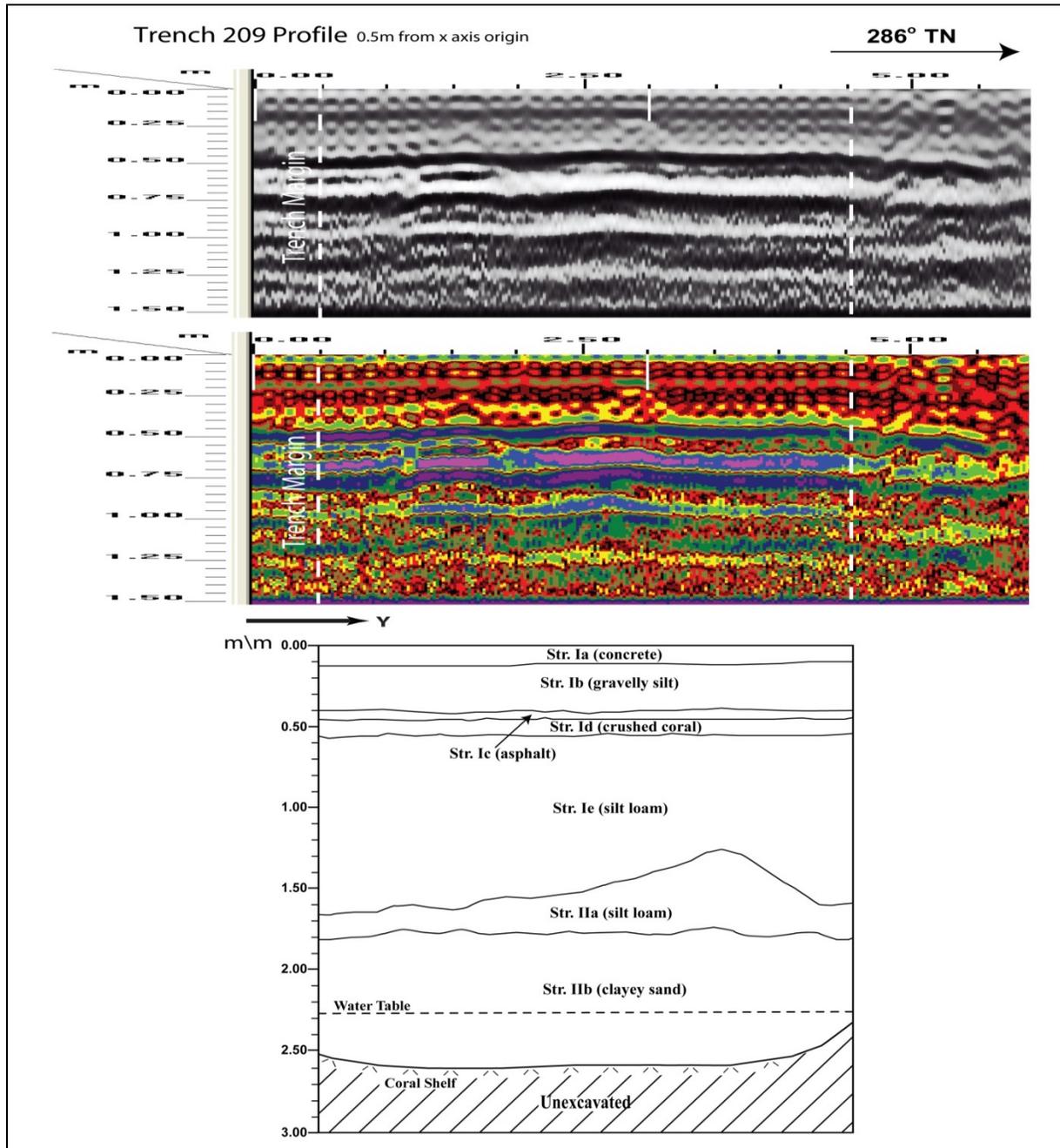


Figure 220. Visual comparison of excavated profile and GPR signal profile of T-209

## Test Excavation 210

Excavation 210 measured 0.8 m by 6 metres and was oriented northwest to southeast and was located within a warehouse 37 m east of Kona Street and Kona Iki street intersection, 9 m north of Kona Street. The GPR grid measured 3 m by 6 m and with 50 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 9 m southwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 221).

GPR depth profiles for T-210 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 222). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.45 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.90 mbs.

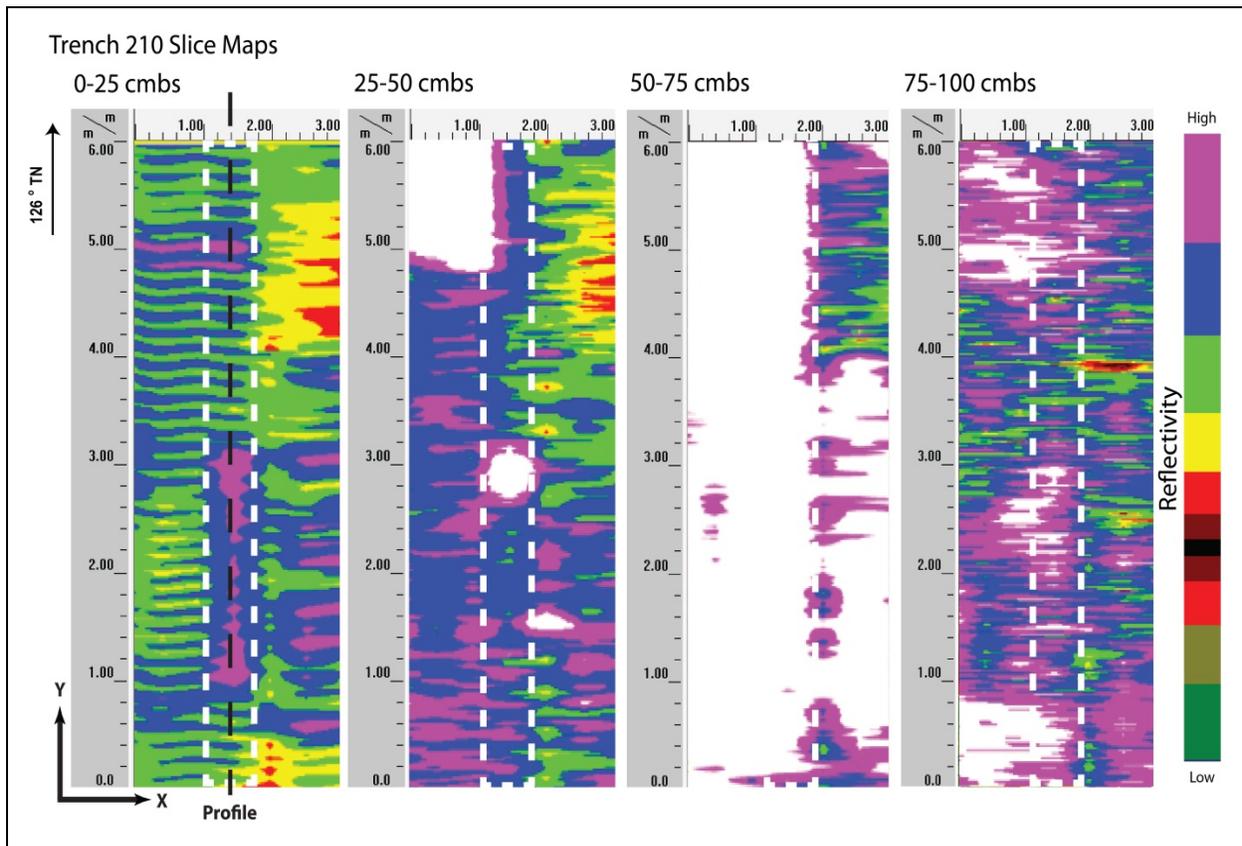


Figure 221. Slice maps of T-210 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 222). Strata Ia to Ic were clearly observed and occurred near the ground-truthed depths. Strata Ia through Ic may be difficult to individually discern, possibly due to the fact that they were very thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. No discrete objects were observed in the GPR results or subsequent excavation.

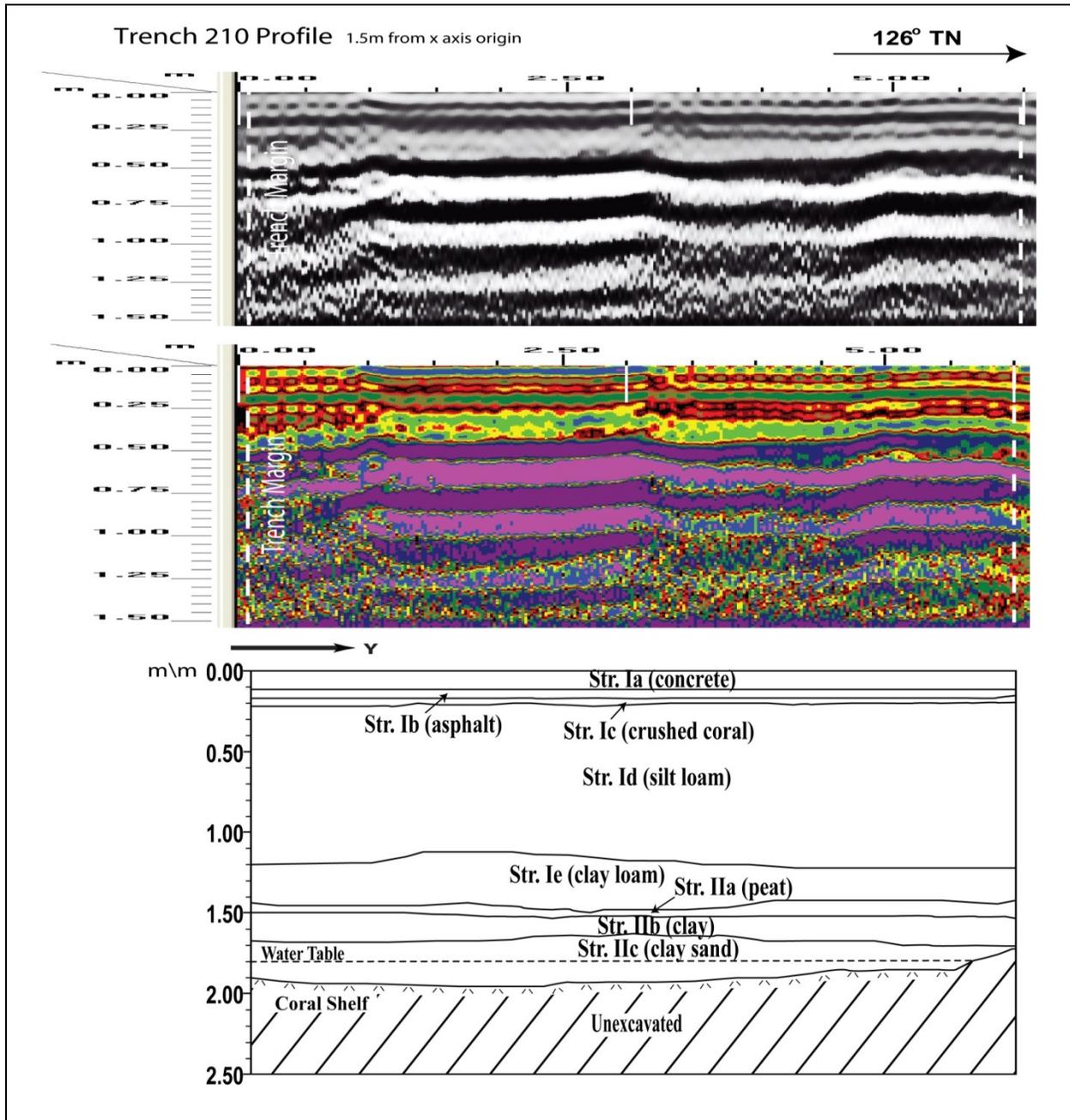


Figure 222. Visual comparison of excavated profile and GPR signal profile of T-210

## Test Excavation 211

T-211 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within a warehouse 58 m east of Kona street and Kona Iki Street intersection, 11 m northeast of Kona Street. The GPR grid measured 3 m by 6 m with 50 cms spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 9 m southwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 223).

GPR depth profiles for T-211 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 224). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.5 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.5 mbs.

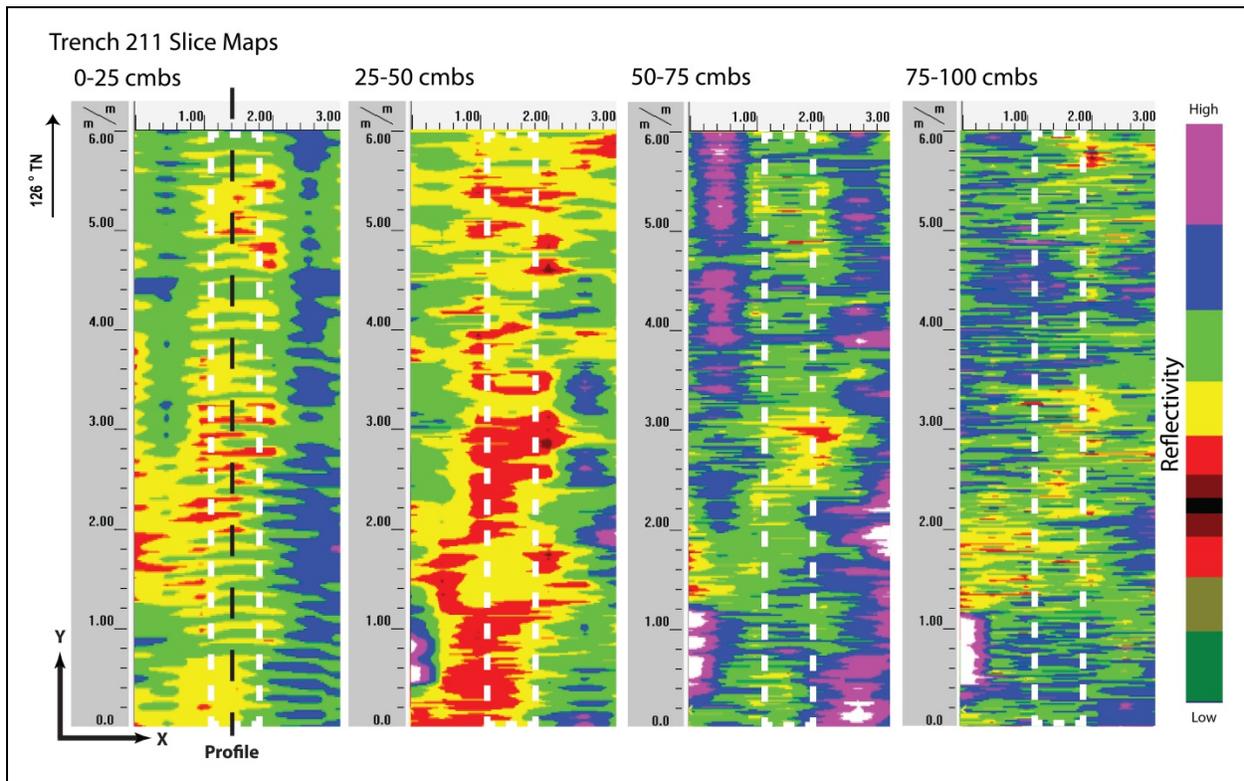


Figure 223. Slice maps of T-211 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a weak correlation in stratigraphic transitions (Figure 224). Strata included, from top to bottom, concrete, silt loam fill, asphalt, crushed coral, silt loam fill, gravelly silt loam fill, natural silt loam, and natural clay. These transitions were not clearly depicted in the GPR profile at the depths that they occurred. No other sediment transitions or discrete objects were observed in the GPR results or subsequent excavation.

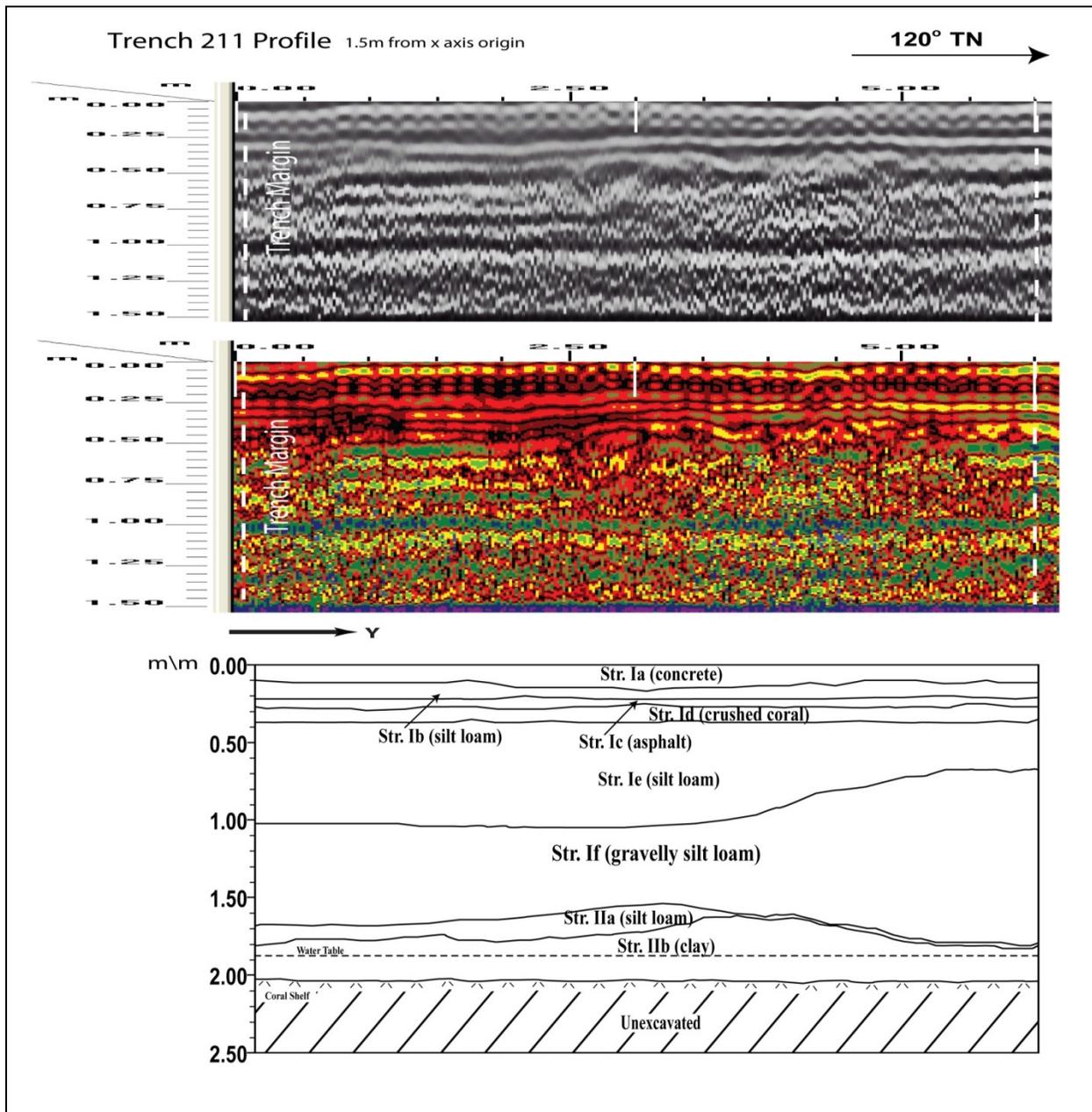


Figure 224. Visual comparison of excavated profile and GPR signal profile of T-211

## Test Excavation 212

T-212 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 68 m southeast of Kona Steet and Kona Iki Street intersection. The GPR grid measured 2 m by 7 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical cable 4.7 m northeast. No utilities transected the excavation location.

A review of amplitude slice maps indicated a linear feature at the northwest end but was not encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the linear feature. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 225).

GPR depth profiles for T-212 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 226). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.4 mbs. An anomaly was observed in the profile but was not encountered during excavation. The maximum depth of clean signal return was approximately 0.8 mbs.

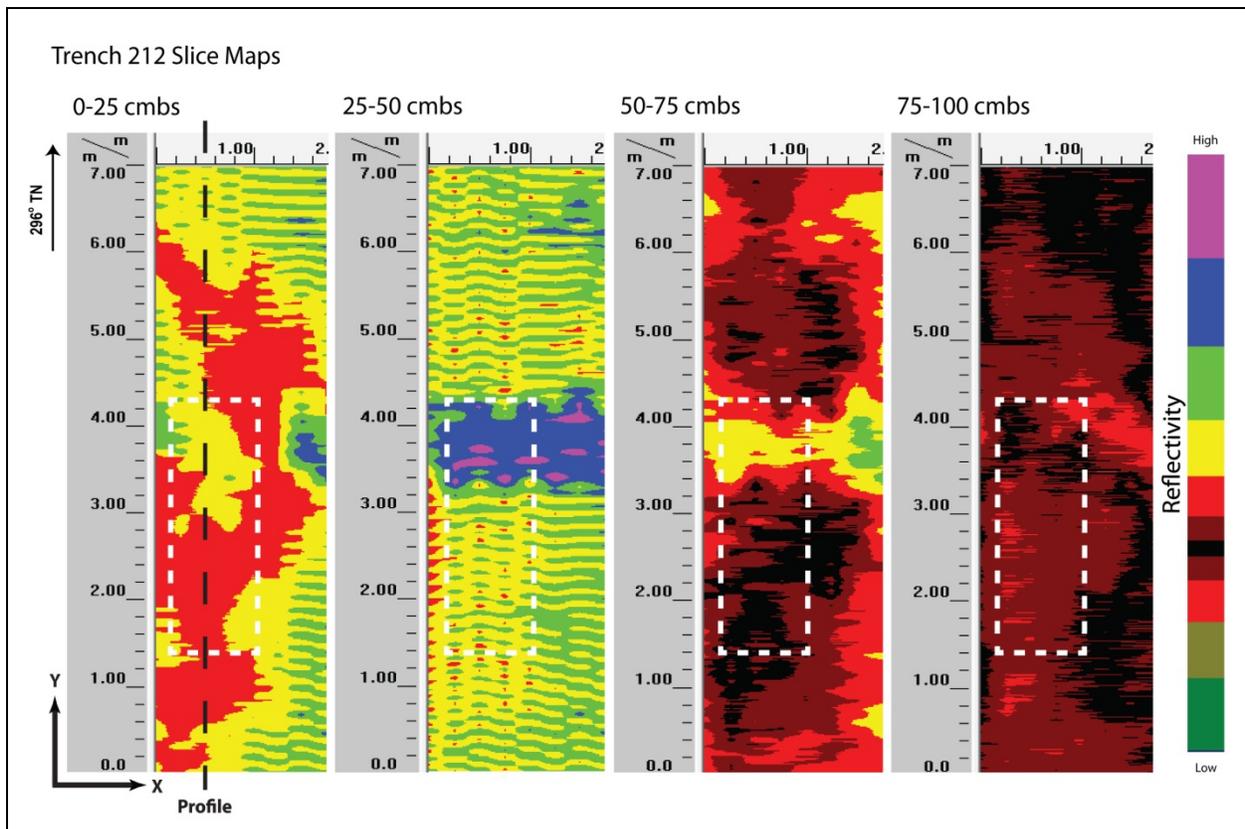


Figure 225. Slice maps of T-212 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 226). Strata Ia to Ic were clearly observed and occurred near the ground-truthed depths. A textural change was observed around 0.5 mbs and may represent extremely gravelly silty sand. No discrete objects were observed in the GPR results or subsequent excavation.

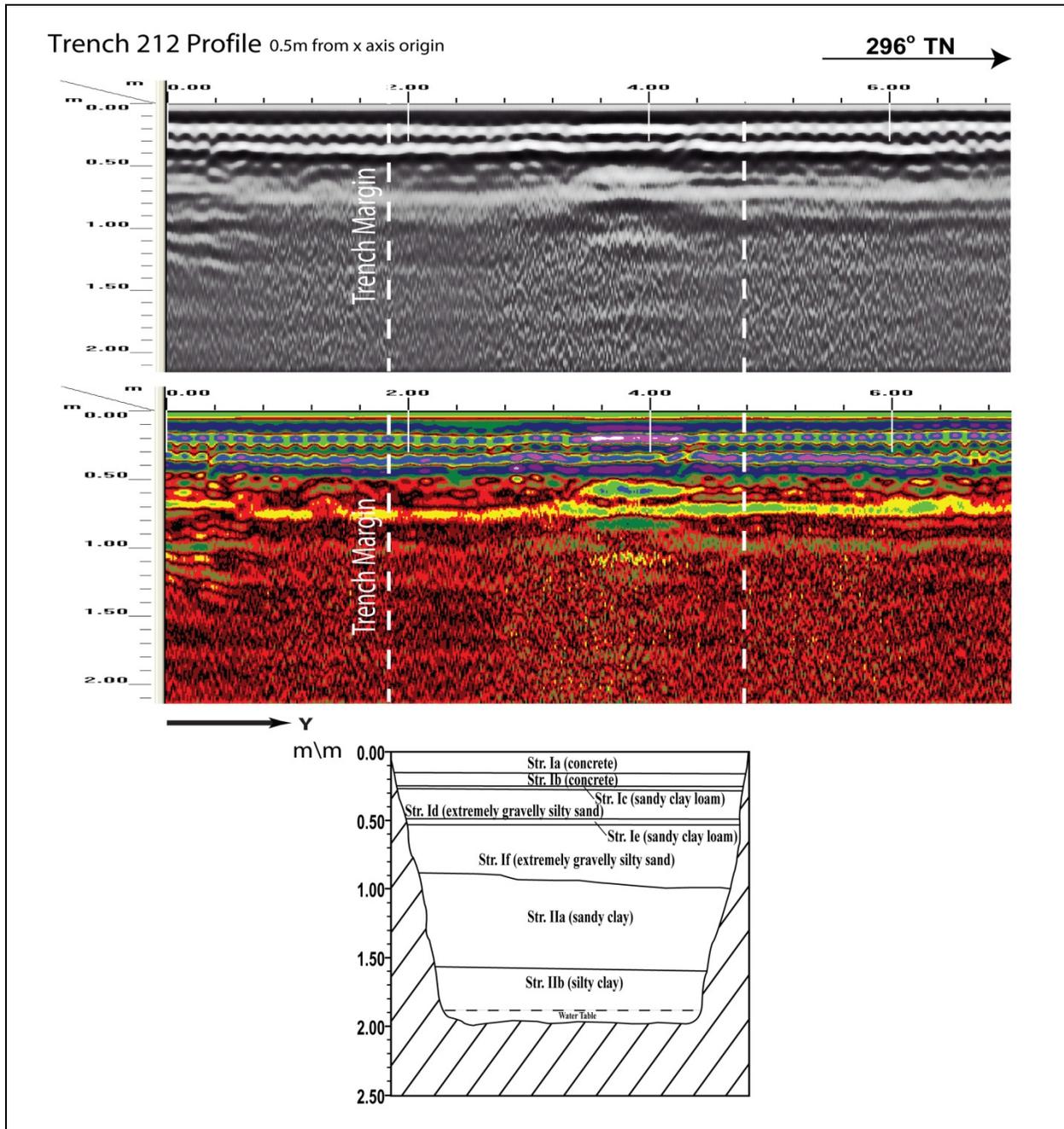


Figure 226. Visual comparison of excavated profile and GPR signal profile of T-212

## Test Excavation 213

T-213 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within a warehouse 65 m east of Kona Street and Kona Iki Street intersection, 6.5 m north of Kona Street. The GPR grid measured 2 m by 6 m with 50 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 5.7 m southwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 227).

GPR depth profiles for T-213 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 228). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.5 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.75 mbs.

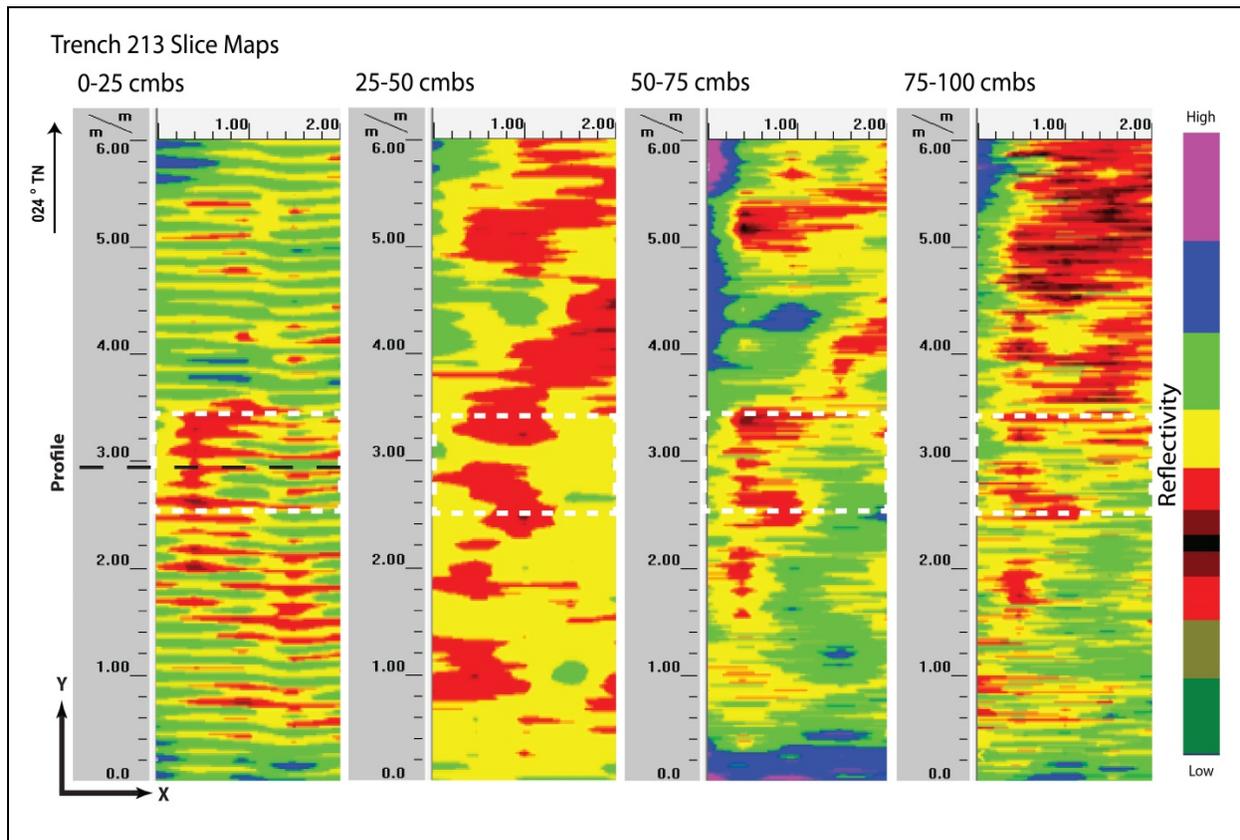


Figure 227. Slice maps of T-213 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a weak correlation in stratigraphic transitions (Figure 228). Strata included, from top to bottom, concrete, silt loam fill, asphalt, crushed coral, cobbly loam fill, cobbly to stony loam fill, and cobbles and boulders. These transitions were not clearly depicted in the GPR profile at the depths that they occurred. No other sediment transitions or discrete objects were observed in the GPR results or subsequent excavation.

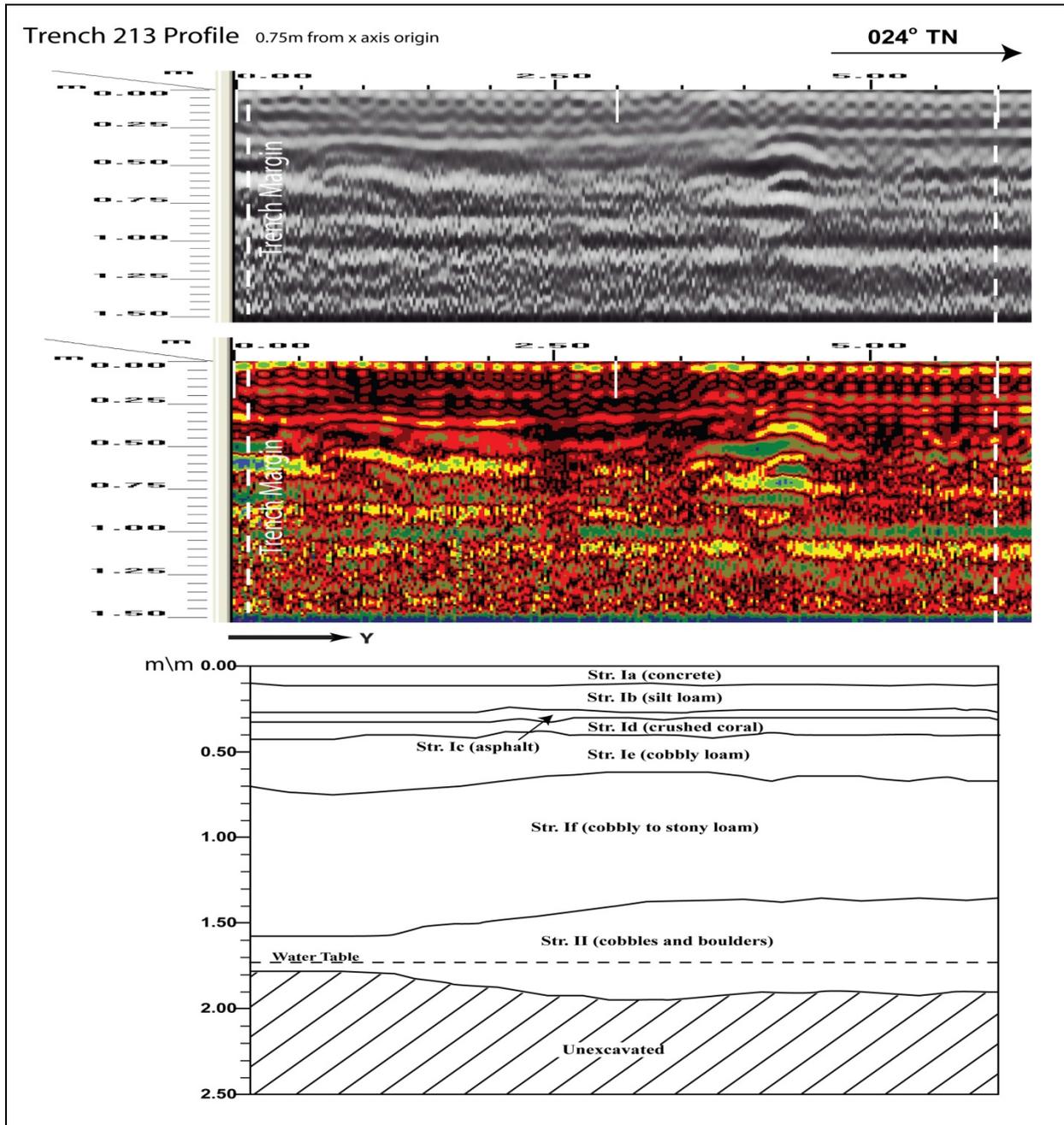


Figure 228. Visual comparison of excavated profile and GPR signal profile of T-213

## Test Excavation 214

T-214 measured 0.8 m by 6 m and was oriented northwest to southeast and was located within a warehouse 75 m southeast of Kona Street and Kona Iki Street intersection, 9.5 m north of Kona Street. The GPR grid measured 3 m by 6 m with 50 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 8.7 m southwest. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 229).

GPR depth profiles for T-214 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 230). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.2 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.75 mbs.

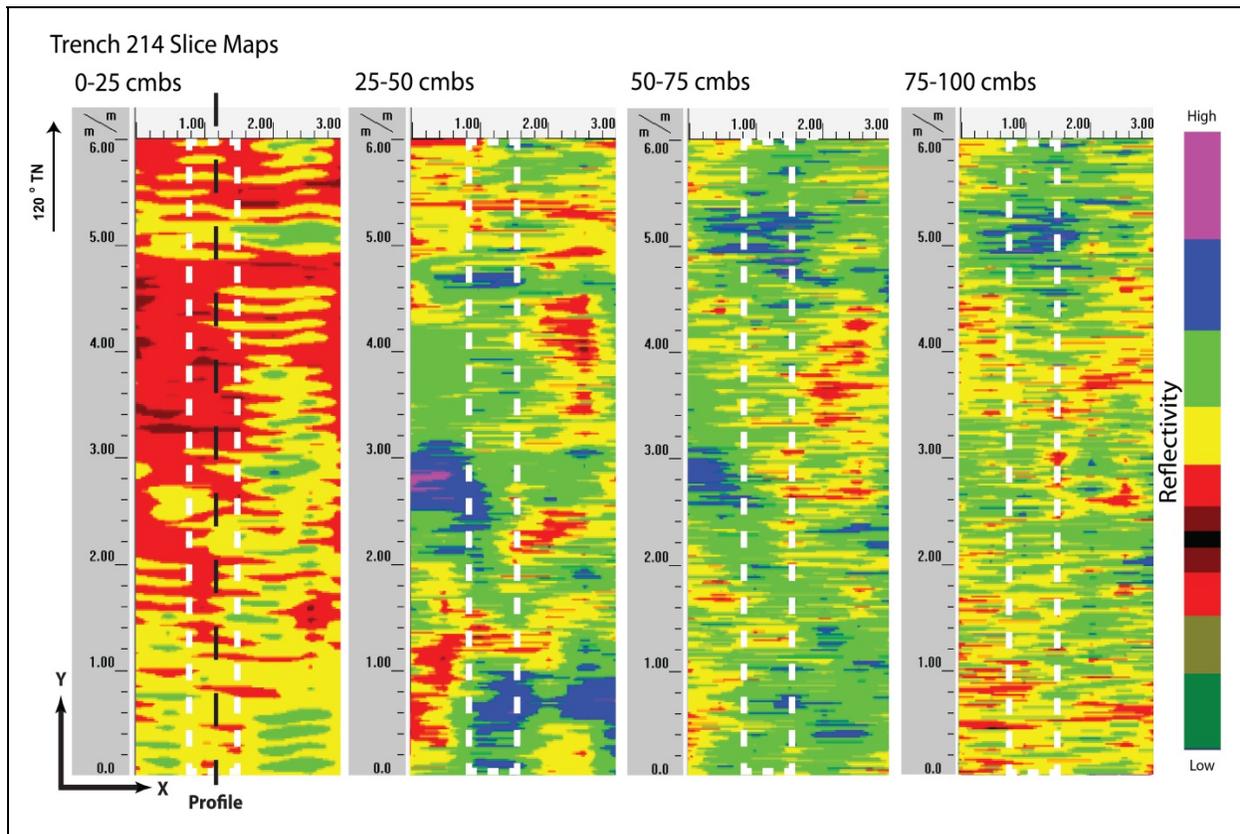


Figure 229. Slice maps of T-214 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 230). Strata Ia to Id were observed and occurred near the ground-truthed depths. Strata Ia through Id may be difficult to individually discern, possibly due to the fact that they were thin layers of compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. No discrete objects were observed in the GPR results or subsequent excavation.

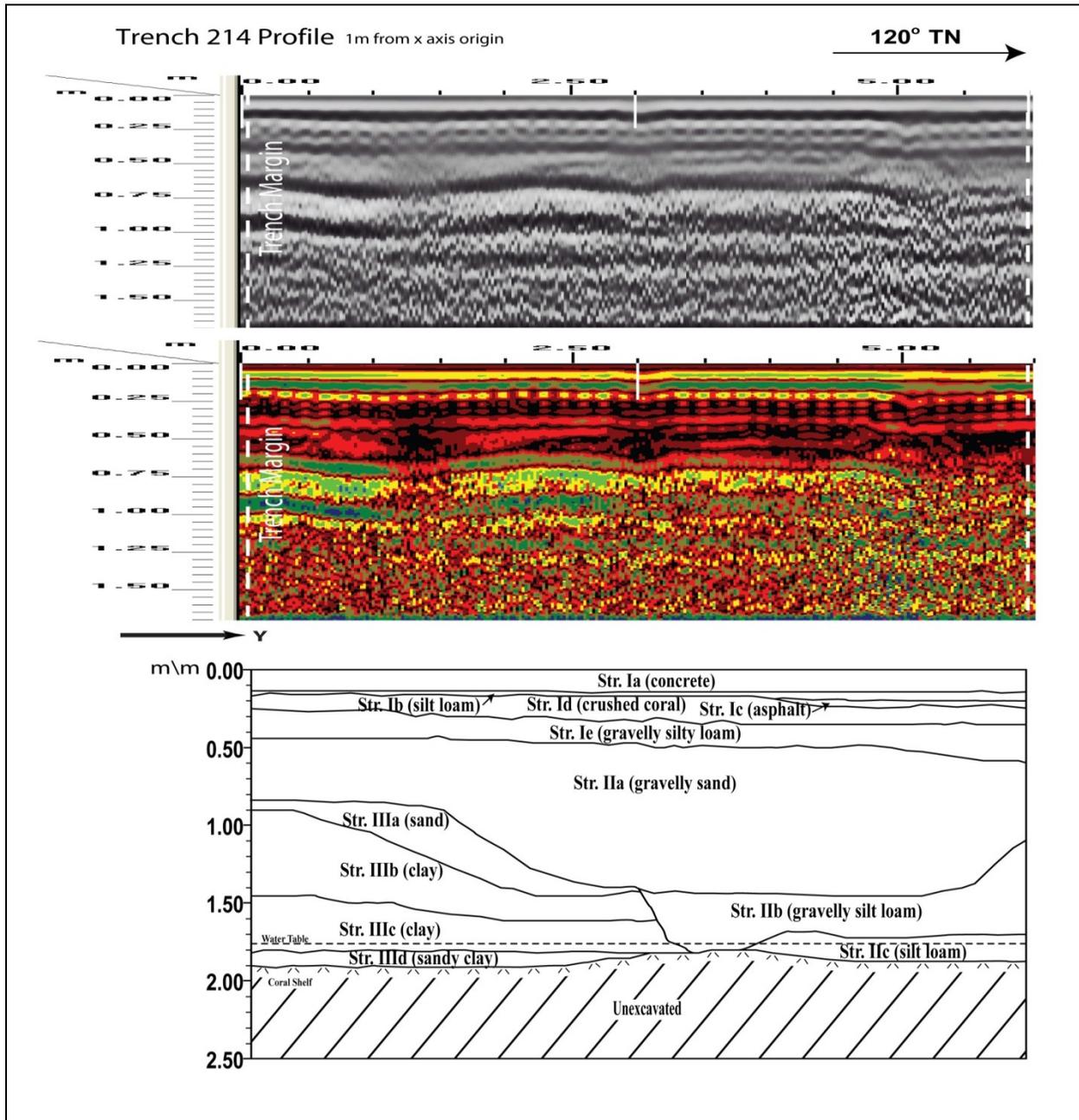


Figure 230. Visual comparison of excavated profile and GPR signal profile of T-214

## Test Excavation 217

T-217 measured 0.9 m by 3 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 100 m southeast of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 7 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 8.9 m southeast. A utility jacket or parking structure foundation column was encountered 0.62 mbs in the center of the excavation.

A review of amplitude slice maps indicated a linear feature but was not encountered but a utility was encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the linear feature. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs and increases again around 0.75 mbs (Figure 231).

GPR depth profiles for T-217 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 232). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.15 mbs and again around 0.85 mbs. An anomaly was observed in the profile and may corresponded to the utility jacket that was encountered. The maximum depth of clean signal return was approximately 1.0 mbs.

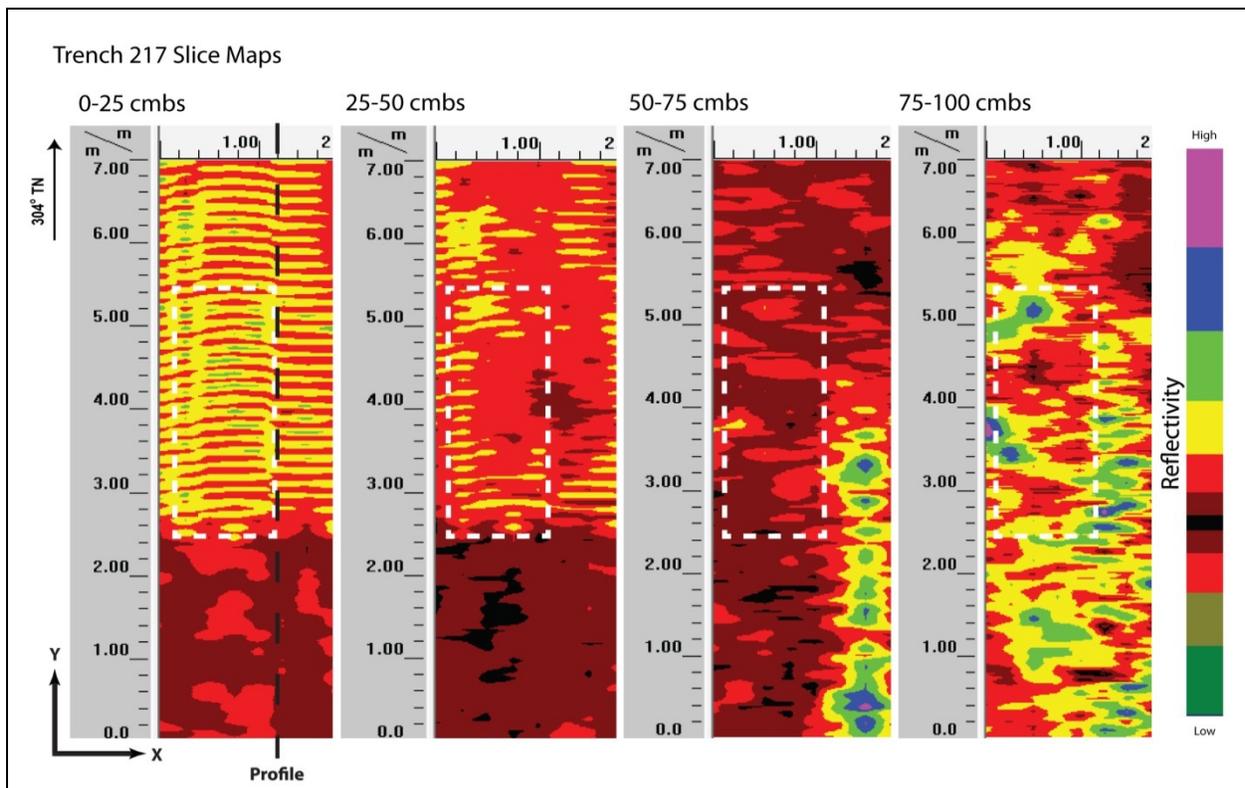


Figure 231. Slice maps of T-217 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 232). Strata Ia to Ic were clearly observed and occurred near the ground-truthed depths. Strata included a layer of concrete on top of sand fill, followed by sandy loam fill and then sandy silt loam and then a cobbly sand fill. A utility jacket was found 0.62 mbs. An anomaly was observed in the profile but does not occur at the same depth as the utility jacket. This could be a result of the wrong dielectric value being used. No other discrete objects or stratigraphic transitions were observed in the GPR results or subsequent excavation.

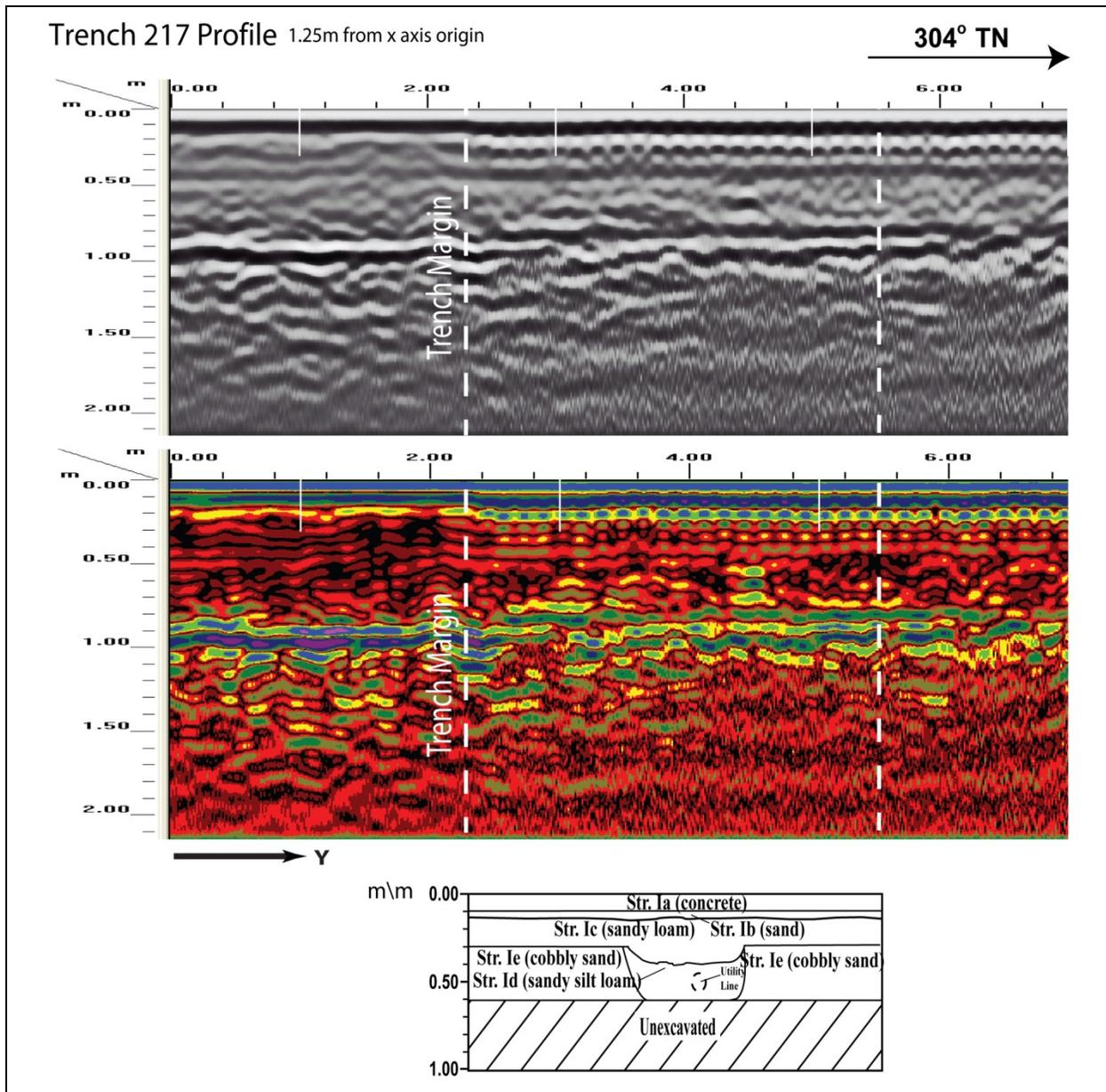


Figure 232. Visual comparison of excavated profile and GPR signal profile of T-217

## Test Excavation 218

T-218 measured 0.9 m by 4 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 70 m southwest of Kona Street and Keeaumoku Street intersection. The GPR grid measured 2 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities within close proximity of the excavation. No utilities transected the excavation location.

A review of amplitude slice maps indicated no linear features which might indicate the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 233).

GPR depth profiles for T-218 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 234). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.4 mbs. No utilities observed in the profile. The maximum depth of clean signal return was approximately 1.15 mbs.

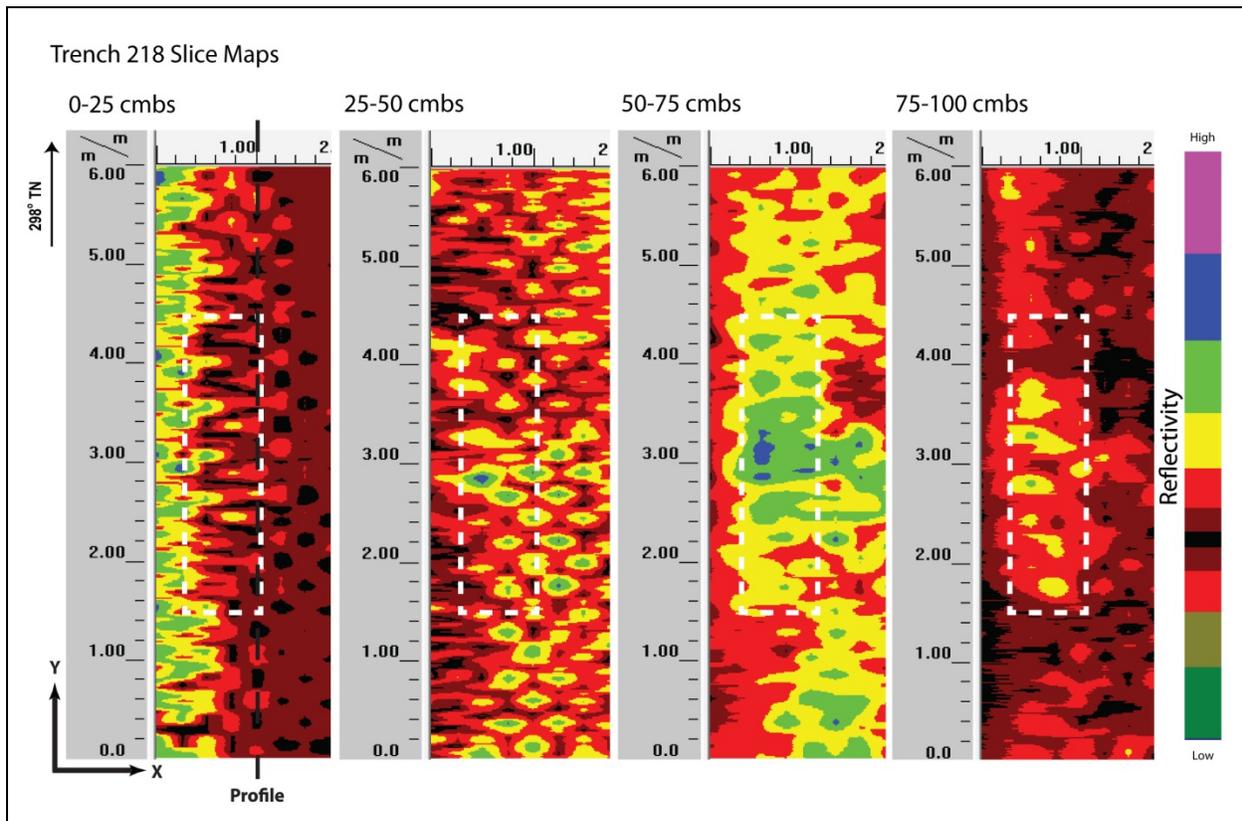


Figure 233. Slice maps of T-218 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 234). Strata Ia to If were all clearly observed and occurred at the ground-truthed depths. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

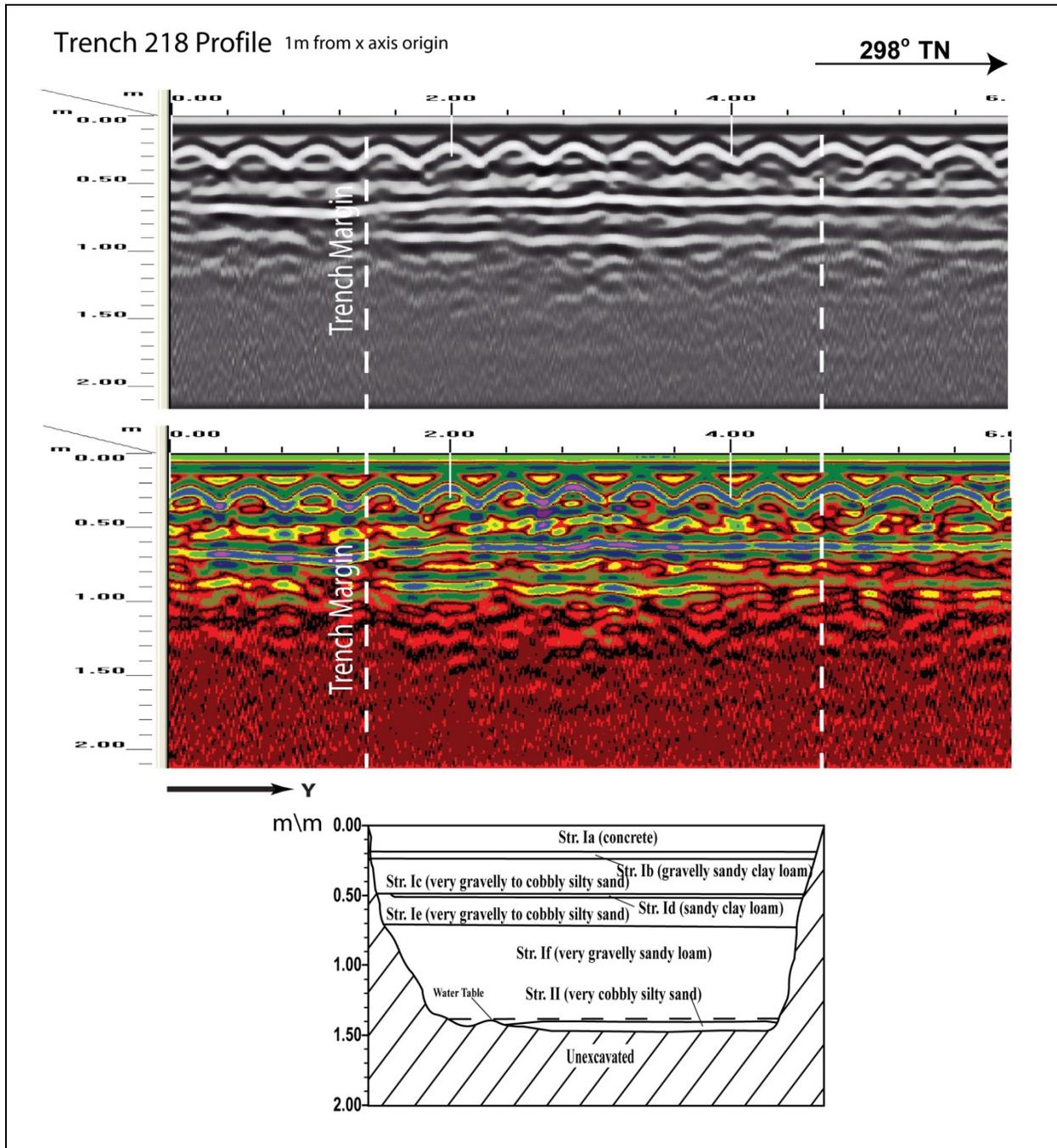


Figure 234. Visual comparison of excavated profile and GPR signal profile of T-218

## Test Excavation 219

T-219 measured 0.9 m by 3 m and was oriented northeast to southwest and was located within a parking lot, 65 m northwest of Kona Street and Keeaumoku Street intersection. The GPR grid measured 2.5 m by 6 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 1 m southwest. A PVC utility was encountered at 0.61 mbs in the south end of the excavation.

A review of amplitude slice maps indicated a linear feature but not within excavation boundaries but a utility was encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 235).

GPR depth profiles for T-219 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 236). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.35 mbs. Anomalies were observed in the profile and one corresponded to the utility encountered during excavation and the other was not within excavation boundaries. The maximum depth of clean signal return was approximately 0.75 mbs.

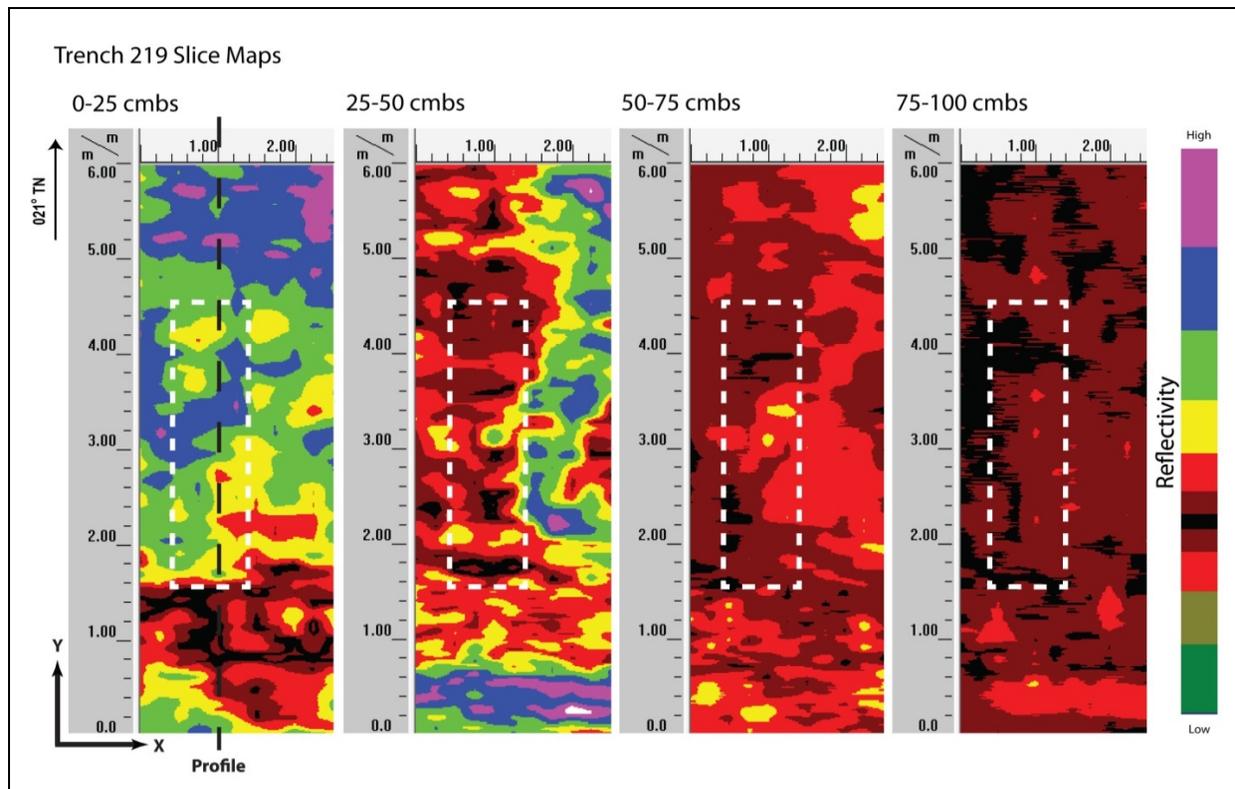


Figure 235. Slice maps of T-219 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 236). Strata Ia to Ic were clearly observed but do not occurred near the ground-truthed depths. All other sediment transitions were below the maximum clean signal return depth. A utility pipe was found 0.61 mbs. This corresponded to a hyperbola anomaly observed in the profile in the same location. No other discrete objects were observed in the GPR results or subsequent excavation.

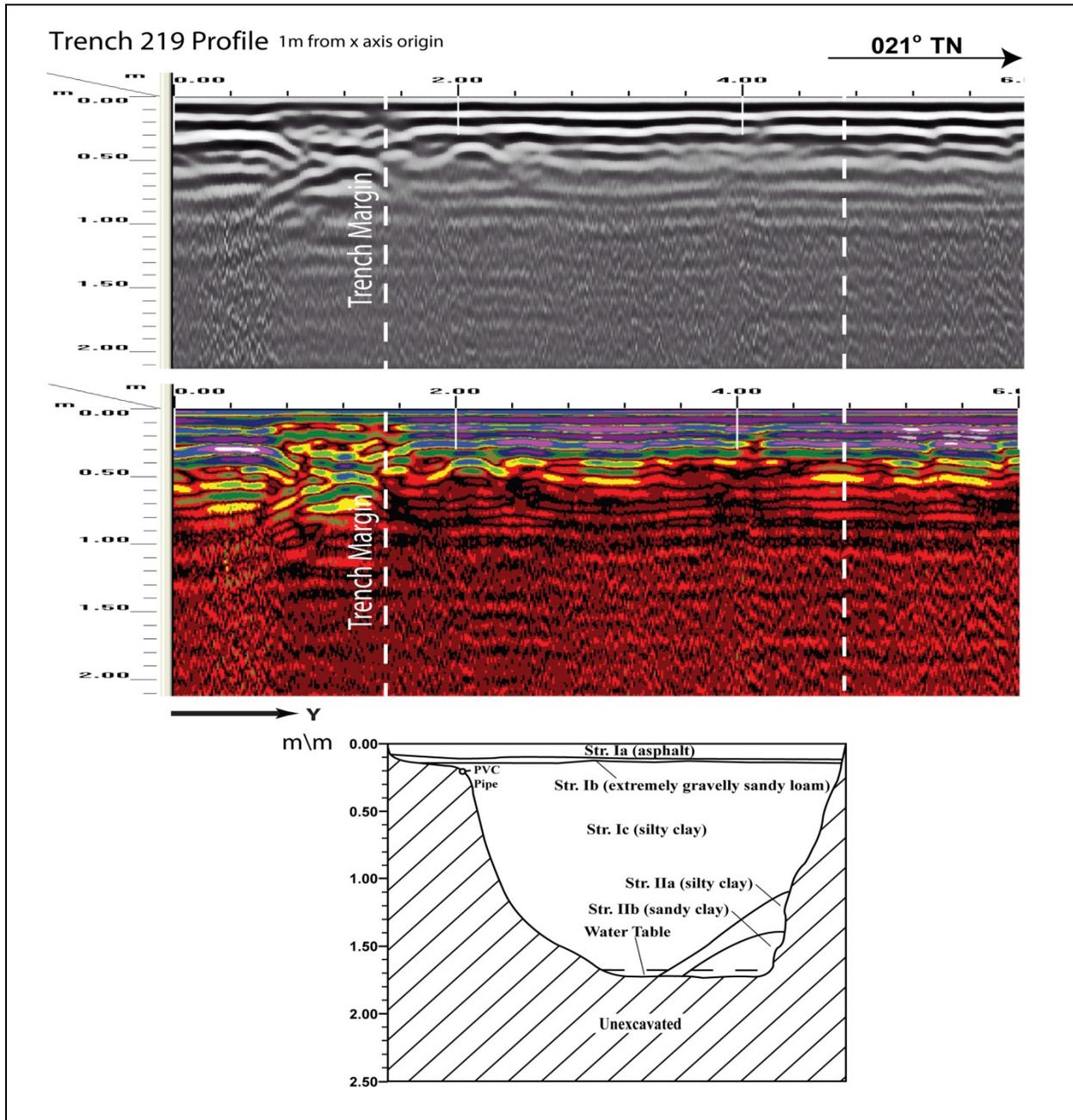


Figure 236. Visual comparison of excavated profile and GPR signal profile of T-219

## Test Excavation 220

T-220 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the sidewalk on Kona Street, 35 m southeast of Kona Street and Kona Iki Street intersection. The GPR grid measured 2 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities located within close proximity of the excavation. No utilities transected the excavation location.

A review of amplitude slice maps indicated a linear feature but it was not encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 237).

GPR depth profiles for T-220 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 238). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.65 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.8 mbs.

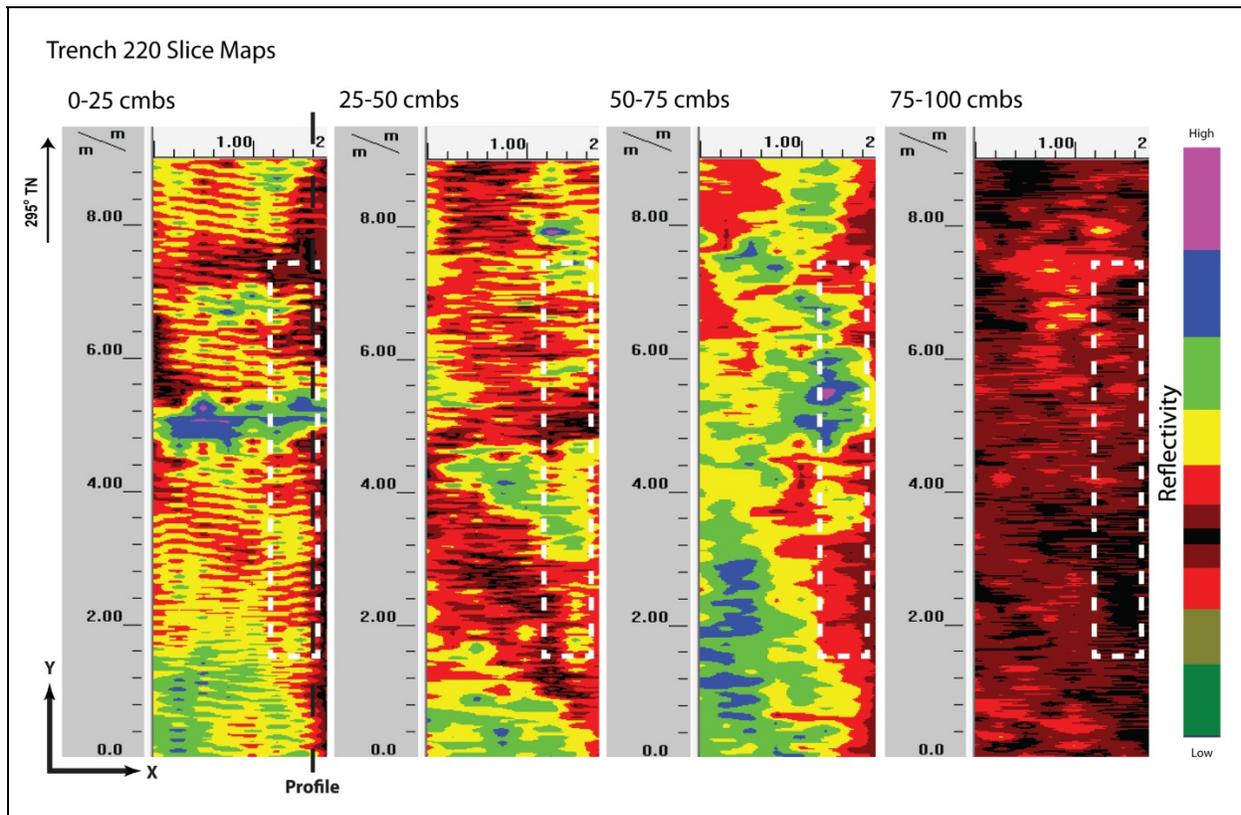


Figure 237. Slice maps of T-220 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 238). Strata Ia to If were clearly observed and occurred near the ground-truthed depths. Strata Ib to Ie may be difficult to individually discern due to the fact that some layers were less than 0.05 m thick. The disturbed filled pit was also not observed in the profile. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

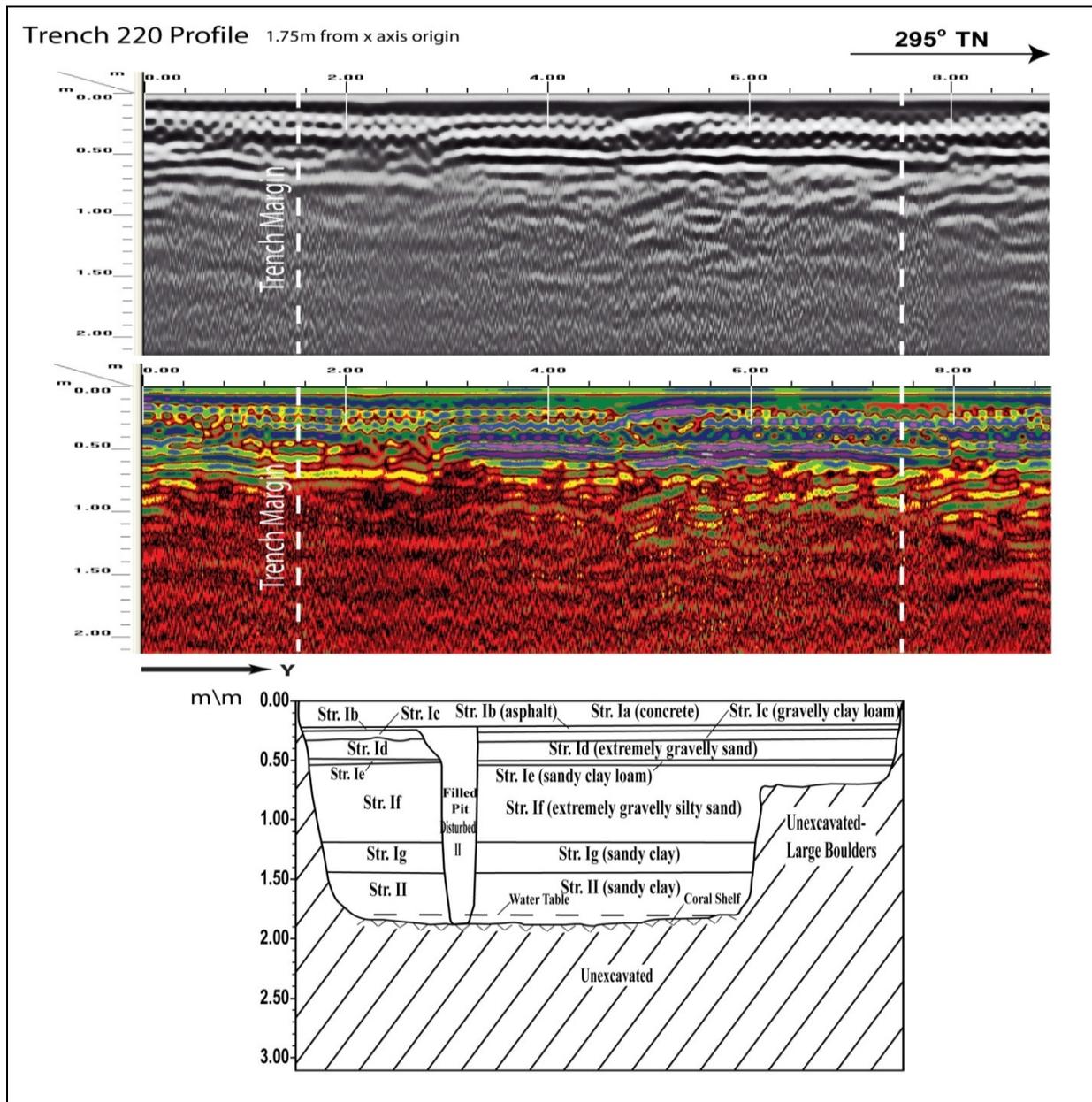


Figure 238. Visual comparison of excavated profile and GPR signal profile of T-220

## Test Excavation 221

T- 221 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 31 m east of Kona Street and Kona Iki Street intersection. The GPR grid measured 3 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water line 1.4 m southwest and 1.7 m southeast, electrical line 1.6 m northeast. A utility jacket/building foundation was encountered approximately 0.25 mbs along the north wall on the west end of the excavation.

A review of amplitude slice maps indicated a linear feature which coincides with a possible utility jacket observed during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except the linear features. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 239).

GPR depth profiles for T-221 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 240). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.3 mbs. No anomalies were observed in the profile although a utility jacket was observed during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

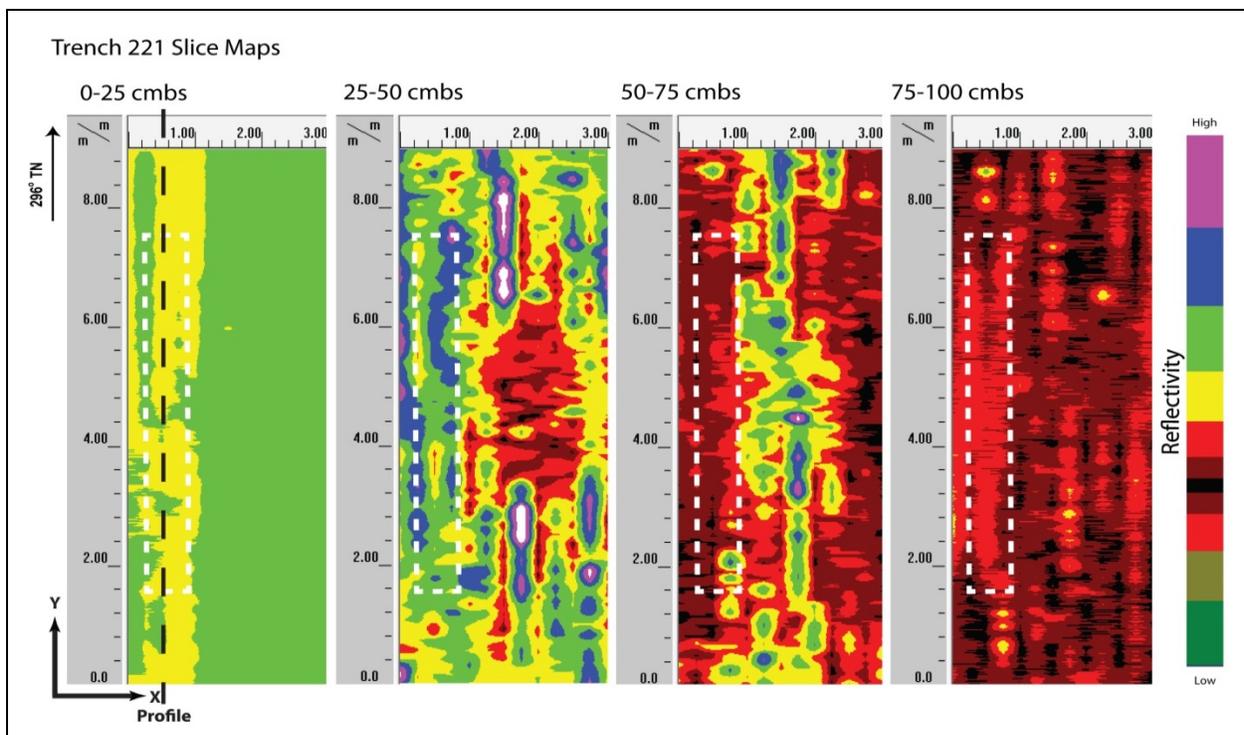


Figure 239. Slice maps of T-221 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 240). Strata Ia to Ic were clearly observed and occurred at the ground-truthed depths. Stratum Ib was difficult to discern due to how it was situated between the other strata and because it was less than 0.1 m thick. All other sediment transitions were below the maximum clean signal return depth. A concrete jacket was found 0.25 mbs. This jacket did not show up on the profile. This may be due to the fact that it was not reinforced with steel (rebar) or that it may have had a similar density to the surrounding stratum. No other discrete objects were observed in the GPR results or subsequent excavation.

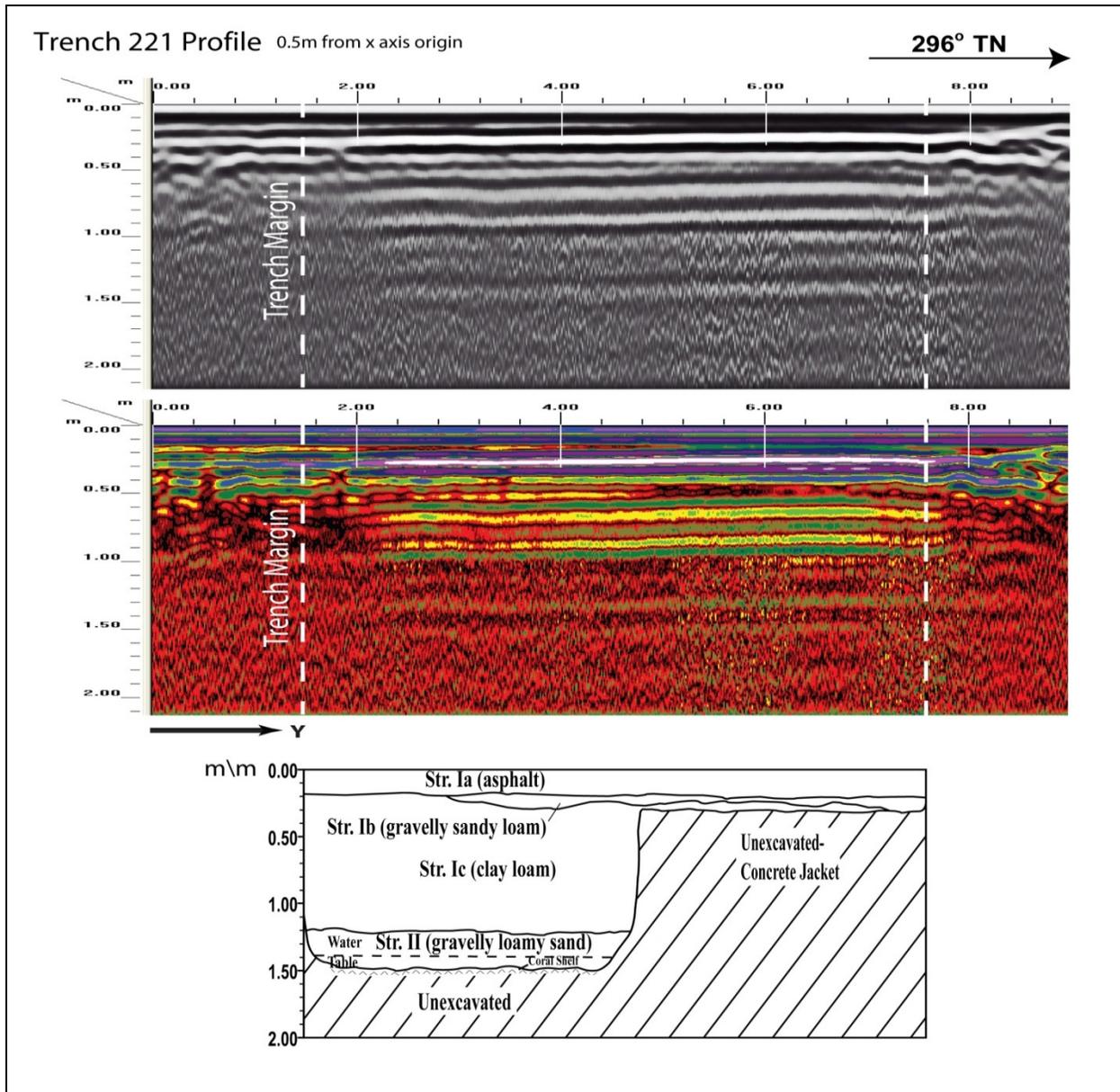


Figure 240. Visual comparison of excavated profile and GPR signal profile of T-221

## Test Excavation 222

T-222 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Kona Street, 60 m southeast of Kona Street and Kona Iki Street intersection. The GPR grid measured 2.5 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 1.5 m northeast and 1.5 m southeast, water line 1.4 m southwest. A broken utility pipe was encountered 0.5 mbs in the east end of the excavation.

A review of amplitude slice maps indicated no linear features although a utility pipe was encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 241).

GPR depth profiles for T-222 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 242). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity that occurred around 0.3 mbs. No utilities were observed in the profile although a utility was encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

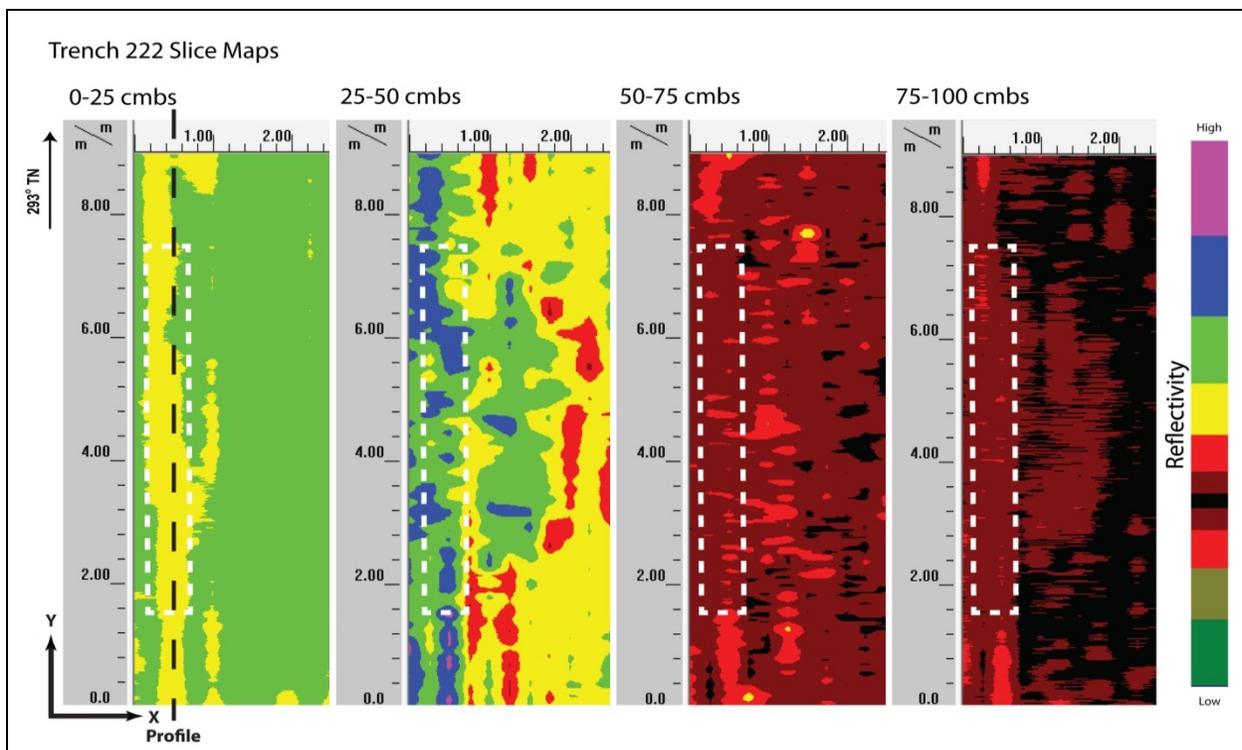


Figure 241. Slice maps of T-222 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 242). Strata Ia and Ib were clearly observed and occurred at the ground-truthed depths. A utility pipe was found 0.5 mbs. This pipe did not show up on the profile or slice maps. This may be due to the fact that the pipe was empty and broken or because it was small in diam. No other discrete objects were observed in the GPR results or subsequent excavation.

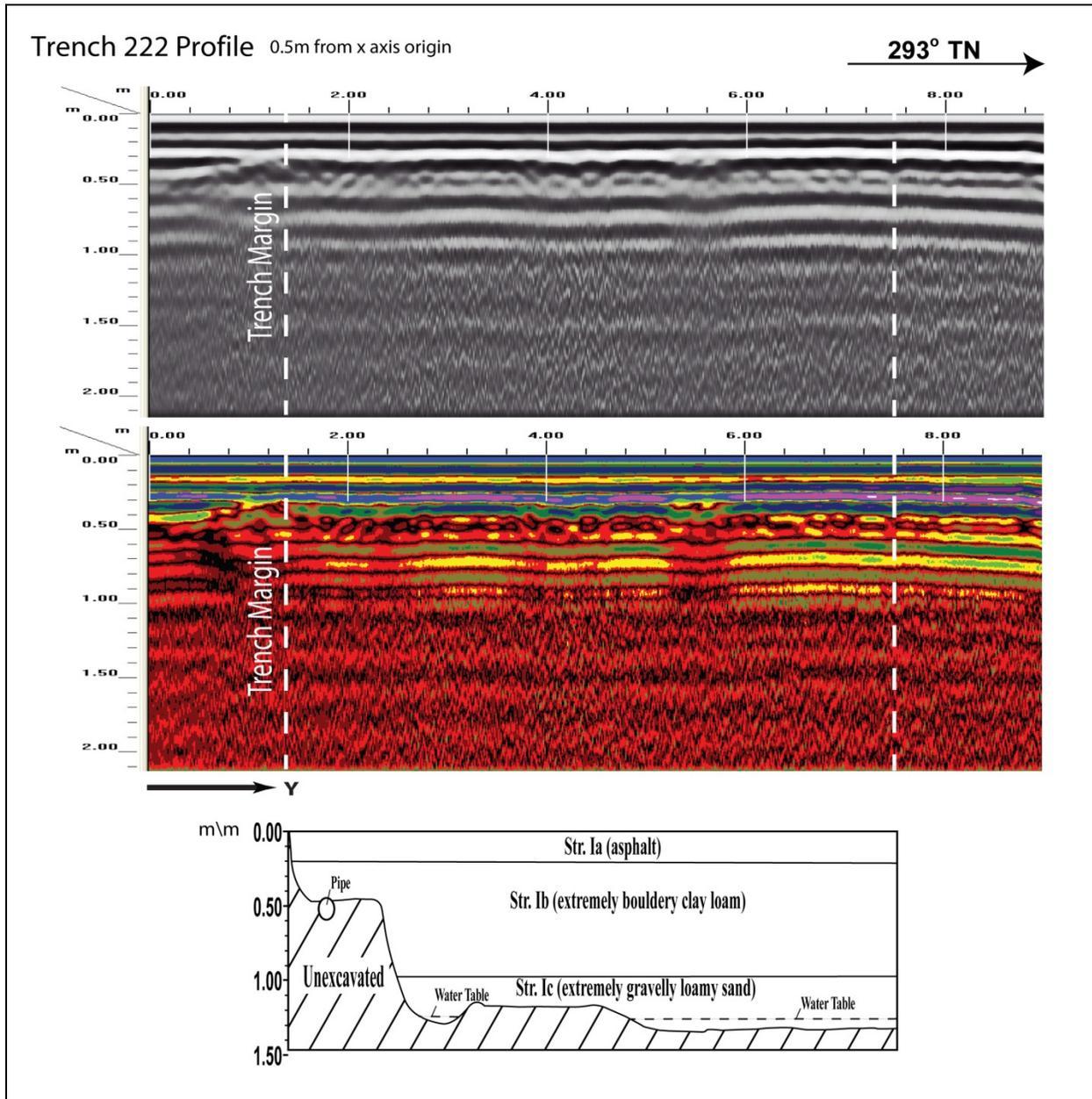


Figure 242. Visual comparison of excavated profile and GPR signal profile of T-222