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# **Appendix E-2**

## 2004 Fault Investigation Report



***FAULT INVESTIGATION, OAK VALLEY AT  
CALIMESA, RIVERSIDE COUNTY, CALIFORNIA.***

***Prepared for:***

***FIESTA DEVELOPMENT, INC.***

***Prepared by:***

***PETRA GEOTECHNICAL, INC.***

***and***

***HUSHMAND AND ASSOCIATES, INC.***

***October 20, 2004***

***J.N. 238-04***

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Mr. Saied Naaseh  
FIESTA DEVELOPMENT, INC.  
470 E. Harrison Street  
Corona, California 92879

**Subject:      **Fault Investigation, Oak Valley at Calimesa, Riverside County, California.****

Dear Mr. Naaseh:

Petra Geotechnical, Inc. (Petra) and Hushmand and Associates, Inc. are pleased to submit our Fault Investigation for the subject project. The results of our investigation indicate the site is traversed by the Cherry Valley fault, which extends westward from the San Gorgonio fault zone. The fault exhibits evidence of Quaternary activity, which decreases along its surface trace from east to west within the boundaries of the site. Accordingly, the following report provides recommendations for structural setbacks for habitable structures within the eastern portion of the fault within the site. The western portion of the fault investigated during this study was not found to be active in the Holocene time period (last 10,000yrs). Therefore, setbacks for residential structures within this portion of the property are not recommended, however, setbacks for public buildings such as schools, fire stations, etc. are recommended.

Petra appreciates the opportunity to be of service to Fiesta Development, Inc. Should you need additional information or any clarifications please call one of the undersigned.

Respectfully submitted,

**PETRA GEOTECHNICAL, INC.**

Robert Ruff  
Senior Vice President

RWR/nls

**FAULT INVESTIGATION, OAK VALLEY AT CALIMESA,  
RIVERSIDE COUNTY, CALIFORNIA**

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**INTRODUCTION**

**Project Description**

The Oak Valley project was adopted by the County of Riverside in 1990 as Specific Plan Numbers 216 and 216A. The development was a golf/recreation-oriented, master-planned community of mixed residential, commercial, recreational, and community uses. The amended plan calls for a mixed-use master planned community providing for about 2996 residential dwelling units along with supportive land uses including neighborhood commercial, recreation center, mixed use, schools, parks, and open space. A major component of the original plan, a golf course, is no longer being proposed.

**Site Description**

The site comprises about 1539 acres, the location of which is shown on Figure 1. This area comprises the northern part of the larger Oak Valley project as described in EIR 229 by Michael Brandman Associates (MBA, 1988) and which constituted about 6725 acres primarily between the I-10 freeway and San Timoteo Canyon Road, and from the San Bernardino/Riverside county line on the north near Yucaipa to the Beaumont area on the south. This area was previously referred to as the Phase 1 area of the Oak Valley project as described in the EIR (MBA, 1988). Access to the site is primarily from County Line Road and Sandalwood Drive exits from the I-10 Freeway.

**Scope of Work**

In accordance with our scope of work discussed in our original proposal and amendments (dated March 18, 2004, May 19, 2004, and June 28, 2004) the scope of work for our geotechnical fault investigation consisted of:

- Collection and review of readily available literature and maps pertaining to geologic conditions within and adjacent to the site,
- Review of development plans available at the time of our investigation,
- Obtaining and reviewing historical aerial photographs to better define fault features within and adjacent to the site,
- Excavation of 20 exploratory trenches to depths ranging from approximately 6 to 18 feet to evaluate the location and degree of activity of the Cherry Valley fault between Interstate 10 on the east and Covington Canyon on the west, a distance of approximately 1.75 miles.
- Detailed Logging of the trenches at a scale of 1" = 5'.
- Preparing a site plan and fault map depicting the location of the exploratory trenches and the Cherry Valley fault.
- Preparation of this report summarizing the conclusions of the study and providing recommendations for siting proposed structures in the vicinity of the fault.

## **BACKGROUND INFORMATION**

### **Previous Investigations**

Geological investigations in the region have been performed since the 1920s (e.g., Frick, 1921); these studies are summarized in the EIR (MBA, 1988). There is little published information available on the specific project area. Of particular importance were the investigations by Dames & Moore (1987) and by Rasmussen Associates (1984, 1988) both of who conducted fault-trenching investigations. Also important is research conducted since the EIR was prepared; specifically, the work of Albright (1999) and Kendrick et al (2002) and fault mapping performed for the April, 2004 geotechnical report by Hushmand and Associates, Inc., and Petra Geotechnical, Inc.

### **Current Study-Method Investigation**

Preliminary investigations included review of published geological literature and project reports. Pertinent reports are referenced within later sections of this report. Stereoscopic aerial photographs were analyzed to characterize the geologic setting of the site and to assist in locating the exploratory trenches. Several vintages of photos (scale of about 1:24,000) taken between 1979 and 1995 were reviewed.

For this report we utilized a reconnaissance level geological/geotechnical map prepared for our previous study conducted in April 2004 by a senior California-licensed, Engineering Geologist, aided by previous maps prepared by others (e.g., Dames & Moore, 1987; Rasmussen Associates, 1984, 1988) and aerial photographs. A revised fault map based on the results of this current study is presented as Plate 1.

Twenty exploratory fault trenches were excavated in two phases during July and August of 2004 using a track-mounted excavator with a 36- to 48- inch- wide bucket. The trenches were logged by a senior engineering geologist at a scale of 1" = 5' with the exception of trench FT-8, which was logged at a scale of 1" = 2'. The trench locations were selected to provide data on the structural characteristics of the fault, fault-zone width, and to provide information related to the age of faulting (Plate 1).

### **SITE PHYSIOGRAPHY**

The Oak Valley project area lies along the western edge of the Beaumont Plain and near the eastern edge of a region referred to as the San Timoteo Badlands. The site is generally a well-vegetated grassland and somewhat more similar to a savanna or wooded savanna than to true badlands which are characterized by little vegetation. The locally rugged relief within portions of the site is probably mainly a result of the area being capped by a hard, erosion-resistant, impermeable, ancient soil with a well-developed carbonate horizon. This hard surface protects

the area from erosion, but once the cap is breached, the underlying uncemented materials are susceptible to erosion and formation of steep-sided canyons.

The site is characterized by flat mesas and ridges transected by northerly, westerly and southwesterly draining valleys and canyons. The mesas and ridges lie at approximately the same elevation and represent a formerly flat to undulatory, gently southwest-sloping surface collectively referred to informally as the Calimesa surface. Elevations of the Calimesa surface are highest within the northern parts of the site where the ridge tops range from approximately 2200 to 2300 feet above sea level. Elevations of the Calimesa surface gradually decrease toward the southwest providing an elevation difference across the site of about 100 feet.

The valleys in the northern part of the property drain toward the north and are tributaries of Yucaipa Creek. Valleys in the east, west, and south drain primarily southwesterly and are tributaries of San Timoteo Creek. The two major valleys within the site are Covington Canyon, which drains southwesterly from the northeast corner of the site to the south-central part of the site, and Burns Canyon, which traverses the southeast corner of the site and drains southwesterly subparallel to Covington Canyon. Maximum relief between canyons and the adjacent ridge tops of the Calimesa surface is commonly in the 100 to 130 foot range with a maximum of about 180 feet in Covington Canyon near the southern property line. Valley profiles range from sharp and V-shaped in the smaller valleys to somewhat broad and U-shaped across the larger valleys. Although commonly steep, the valley walls are generally covered with thin deposits of slopewash and colluvium.

### **REGIONAL GEOLOGY AND STRUCTURE**

The subject property is within a very complex geologic area of San Gorgonio Pass (Allen, 1957), which is an area of relatively low topographic relief between two high-standing mountain ranges. These ranges include the San Bernardino Mountains to the north, and the San Jacinto Mountains toward the south, both of which contain peaks over 10,000 feet in elevation. In general,

sediments occupy the relatively low-lying area in San Gorgonio Pass, and crystalline bedrock comprises the mountainous areas (Matti et. al., 1992b). Numerous active faults associated with the San Andreas fault system (Powell, 1993; Treiman, 1994) exist in the region, which produce abundant microseismicity (Nicholson et. al., 1986; Seeber and Armbruster, 1995; Magistrale and Sanders, 1996) and surface rupture events (For example, see Sieh and Yule, 1999; Yule, 2000).

Oak Valley is located on the northeastern limb of a regional asymmetric, northwest-trending anticline in the San Timoteo Formation. The axis of this fold is located west and southwest of the project boundaries and parallels the San Jacinto fault. Bedding planes and member contacts in the San Timoteo Formation on the west limb of the fold typically dip 15 to 50 degrees southwest. On the east limb, including the area beneath Oak Valley, bedding planes and member contacts typically strike northwesterly to northeasterly and generally exhibit gentle dips ranging from nearly horizontal to about 5 degrees to the north, with local increases in dip to about 15 degrees.

Locally, steeper dips typically occur in association with deformation along the north side, or hanging wall, of the Cherry Valley fault. These dips range from greater than 15 degrees to vertical and, in some places, bedding is overturned directly above the fault zone. A gentle anticline and syncline are also exposed in the arroyo walls of Covington Canyon north of the subject fault in the western part of the site. Our previous field reconnaissance performed in April 2006 by this office also identified two small northeasterly dipping faults in the walls of the arroyo near these folds. Toward the east, the late-Pleistocene erosional geomorphic surface north of the subject fault exhibits an open-fold that likely developed as a result of deformation associated with activity across this fault.

### **Regional Faulting**

The site lies between three major active fault zones of the San Andreas fault system (Powell, 1993). These include, the northwest-trending San Andreas fault zone toward the northeast, the

northwest trending San Jacinto fault zone toward the southwest, and the east-west trending San Gorgonio Pass-Banning fault zone to the east. More specifically, the subject site is located at the westernmost end of the San Gorgonio Pass fault zone.

Most faults associated with the San Andreas and San Jacinto fault zones are strike-slip which are faults dominated by horizontal movement of rocks across the faults. Faults within the San Gorgonio-Banning fault zone are a combination of strike-slip and reverse/thrust faults, which accommodate vertical and horizontal motion due to regional compression associated with a left bend in the San Andreas fault in the San Gorgonio Pass region. The Banning fault lies just northeast of the site and is not believed to be active west of Banning (Rasmussen, 1982). Southwest of the Banning fault is the San Gorgonio Pass fault zone, which represents a complex system of northerly dipping oblique-reverse faults. A western strand of the San Gorgonio Pass fault zone, the Cherry Valley fault, extends onto the site from the east, and “dies out” toward the west within the property. The Cherry Valley fault is a thrust fault with a low to moderate northerly dip. Repeated motion across this fault in the late Pleistocene time has offset and deformed units of the San Timoteo Formation within the property.

### **Regional Geologic Rock & Soil Units**

The region surrounding the property consists of late Tertiary- and Quaternary-aged sediments and sedimentary rocks overlying ancient crystalline basement rocks. The basement rocks typically consist of Mesozoic plutonic rocks (e.g. granites, diorites) and Mesozoic through Precambrian-aged metamorphic rocks (e.g. gneiss; Powell, 1993; Matti, et.al., 1982; Matti, et.al. 1983; Dibblee. 1964).

Sedimentary rocks in the region consist of Miocene- to Pleistocene-age conglomerate, sandstone, siltstone, and shale of fluvial (river) origin and local clay beds of possible lacustrine (lake) origin. In the San Timoteo Badlands, the oldest sedimentary rocks are the late Miocene-Pliocene age Mount Eden Formation overlain by the Pleistocene San Timoteo Formation (Shuler, 1953;

Dibblee, 1981; Morton and Matti, 1993). Both of these units were deposited in a basin that extended westward and southward from the then highstanding San Bernardino Basin and adjacent mountains (Morton and Matti, 1993). The regional geology of the area around the site is shown on Figure 2. The valleys in the region are filled with late-Quaternary-age sediments (mostly Holocene) consisting of alluvium, slopewash, and alluvial-fan deposits. Descriptions of the geologic units encountered during our study are provided in the Local Geology section below.

### **LOCAL GEOLOGY**

Numerous geologic units were encountered during our field investigation, which was primarily focused in the eastern portion of the property along the Cherry Valley fault. A description of the units encountered in the exploratory trenches is provided below.

#### **Site Stratigraphy**

The geologic units described in this report consist of the Pleistocene San Timoteo Formation and relatively younger valley alluvium, in addition to important soil profiles that developed within these two formations. The distribution of these sediments is shown on Plate 1 of the Limited Geotechnical Investigation report prepared by Hushmand Associates, Inc. and Petra Geotechnical, dated June 2004. These units, from oldest to youngest, are described further below.

#### **San Timoteo Formation**

The San Timoteo Formation is Pleistocene in age or 1.5 to 1.3 million years old (Morton and Matti, 1993). The formation is divided into three members (Shuler, 1953). The formation onsite represents the upper member, whereas the middle and lower members are present in the deep subsurface. The entire formation along with probable older sediments, reach a total thickness of over 5,000 feet beneath parts of the Oak Valley development.

The San Timoteo Formation is chiefly of fluvial (river) origin with local lacustrine (lake) deposits and is composed of beds of siltstone, sandstone, silty sandstone, claystone, and poorly sorted gravelly to bouldery sandstone and conglomerate. Gravels in the unit are composed of quartz, plutonic (e.g., granite, diorite), meta-sedimentary, meta-igneous, and meta-volcanic rock types. The rock fragments are subangular to subrounded indicating short transport distance. These deposits were principally derived from rocks to the north and northeast in the San Gabriel and San Bernardino Mountains (Albright, 1999). The sediments in outcrop are generally friable to moderately indurated, and easily to moderately erodible. Bedding varies from thin to thick, and well-defined to poorly developed beds with gradational contacts.

### **Alluvium**

The canyons and valleys within the site contain young alluvium of Holocene age. A pedogenic analysis of the alluvium in Trench FT-4 that is typical of most of the thicker valley alluvium within the eastern portion of the site, suggests a maximum approximate age of 5000 years (mid-Holocene; Bornyasz, Appendix B). This alluvium is primarily locally derived from upstream outcrops of the San Timoteo Formation. The material is generally composed of dark-reddish-brown and dark brown, loosely indurated, sand to silty sand with minor amounts of gravelly sand with occasional boulders. The alluvium is massive to poorly bedded.

The young alluvium is relatively thin in small tributary canyons and thicker in the larger drainages and at the canyon mouths. The arroyos in the narrower parts of smaller valleys indicate thicknesses of only about 5 feet to as much as 20 feet.

### **Pedogenic Soils**

Pedogenic soils form by weathering processes on the San Timoteo Formation and other younger valley-fill sediments. Pedogenic soil characteristics typically change as the soil develops over time, and thus, can provide an estimate of the age of the surface on which the soil developed. These soils exhibit ages varying from late Pleistocene, on the order of 100,000 years to only a

few thousand years in age. Because of their relatively young age, they are extremely useful in determining the activity of faulting. Soils can be divided into several recognizable layers or horizons; their degree of development in terms of their physical, chemical and mineralogical properties are indicative of their age. The soil profile consists of the vertical arrangement of all the soil horizons from the surface to the parent material. The principal soils and soil horizons exposed during the investigation are described below. A summary of the characteristics of each horizon is also provided on the Trench Logs (Plates 2 through 9).

A horizon: The A horizon is a thin surficial unit consisting of an accumulation of organic matter mixed with a more dominant loosely consolidated mineral fraction. This horizon, because of its surface position is the youngest soil horizon and is estimated to be late-Holocene in age.

Bt horizon: The Bt or argillic horizon is present in most of the trenches and may or may not be overlain by a thin A-horizon. This soil unit consists of hard, dark-brown, sandy clay and clay in the form of blocks and prisms, and moderately to well-developed clay films on ped surfaces. Soils with a well-developed thick Bt horizon generally may be assigned a minimum age of latest Pleistocene. Bt Horizon soils of Trench FT-20 were determined by Borneyasz (Appendix B) to have an age of approximately 100,000 yrs. based on statistical comparison of the soil development on site with dated regional soils developed under similar conditions.

Btk horizon: The Btk horizon is a clay-rich horizon with later accumulation of carbonate in the form of thin filaments, small flecks, or as thin linings on ped surfaces.

K horizon: The K soil horizon is characterized by abundant calcium carbonate in the soil profile. In this horizon most mineral grains are coated or engulfed with carbonate to form a white to light gray unit in outcrop. In some trenches the K horizon is laminated.

CBk horizon: This horizon is transitional between slightly weathered parent material (hard, blocky siltstone of trench FT-6) and the more-weathered Btk horizons. In trench FT-6 the CBk horizon grades laterally to a white K horizon.

CK horizon: The CK horizon represents a transitional zone between relatively unweathered parent material and the K horizon. Calcium Carbonate occurs, but the parent material is prominent and recognizable.

**Artificial Fill**

There are a few local areas within the site with artificial fill. Generally these are small berms or dams built to retain water for livestock. The only area with significant fill is the valley just south of the trailer park in the central part of the site near Trench FT-5. This area served as an equipment storage area and has been a borrow area. These activities have resulted in dirt, brush, and trash having been disturbed and pushed into the arroyo. Several other areas along the creeks also have local accumulations of trash and generally are not significant to the project.

**ON-SITE FAULTING AND DEFORMATION****The Cherry Valley Fault and Style of Fault Related Deformation**

The Cherry Valley fault extends into the southeast corner of the property (Figure 2 and Plate 1) from offsite to the east (Matti et al, 1985, 1992; Dames and Moore, 1987; Rasmussen and Associates, 1984, 1988). According to mapping by Matti and others, (1992), this fault represents the westernmost extension of the San Gorgonio Pass fault zone that apparently dies out south of a series of northeast trending faults in the Crafton Hills area (Figure 2). According to Matti and others (1992) all faults of the San Gorgonio Pass fault zone are at least late-Quaternary in age and the faults within the eastern portion of the zone between Beaumont and Whitewater exhibit evidence of Holocene activity.

Motion across the Cherry Valley fault is primarily reverse (rocks on the north side of the fault move upwards) with a relatively minor component of strike-slip (horizontal motion). The fault generally dips towards the north approximately 30 degrees across the site. Repeated surface rupturing earthquakes across this fault in the late Pleistocene within the property has “pushed” San Timoteo formation up and over itself. Within the eastern portion of the fault on the site, surface rupture across the Cherry Valley fault displaced a surficial late Pleistocene soil. Considerable secondary folding and faulting has occurred in the rocks above the main fault zone (rocks north of the fault), which in places has tilted the sediments of the San Timoteo Formation

toward the south to vertical or even overturned. In contrast, rocks south of the main fault zone shown on Plate 1 are relatively undeformed and typically exhibit regional dips of the San Timoteo Formation and minor secondary faulting.

Based on our evaluation of the data acquired during our field investigation, the Cherry Valley fault within the property has been subdivided into two sections based on recency of activity along the fault. These two sections are called the Western and Eastern fault zones, and are shown on Plate 1.

### **Age of Faulting**

Our investigation revealed that the Cherry Valley fault can be recognized in the eastern portion of the site by an eroded and degraded scarp associated with folding and displaced strata of the San Timoteo Formation. The scarp in the southeast corner of the site is 70 to 80 feet high and the mesa surface north of the fault in this area, which represents a late Pleistocene erosion surface, appears to be warped upward and tilted slightly to the north as a result of faulting. To the west, the scarp height steadily diminishes from approximately 80 feet near trenches FT-9 through FT-12 to approximately 10 feet at trench FT-16. West of trench FT-16 the fault has no geomorphic expression where it rises onto the surface of a nearly level mesa.

Field investigations of the Cherry Valley fault by Dames & Moore (1987) were inconclusive regarding the recency of its activity. They considered it to be potentially active since it displaces Pleistocene sediments. Furthermore, this evaluation was also based on the work of Matti, et.al. (1985) where it was indicated that the San Gorgonio fault displaces Holocene deposits east of the site. Accordingly, they recommended a restricted-building zone or setback zone. Subsequent work onsite by Rasmussen Associates (1988) suggested that the fault is overlain by the unfaulted mature soil. They, therefore, concluded the fault should not be considered active.

Neither of the above two studies were sufficiently extensive to provide conclusive data that would allow a more-definitive age classification. The purpose of our recent study, which included 20 trenches located between the eastern limits of the site near I-10 and Covington Canyon on the west, was to investigate the fault in a sufficient number of localities to determine its degree of activity in more detail. Observations of the faulted and unfaulted relationships of pedogenic soils along the fault trace enabled a reclassification and further definition of the age of most-recent faulting.

It is our professional opinion, based on our analysis of fault data acquired during our study, that in the western portion of the site (Western fault zone) the fault was inactive during the Holocene. Additionally, in the eastern portion of the property, (Eastern Fault Zone) the age of most recent faulting is either indeterminate or geologic evidence is suggestive of possible Holocene activity. The boundary between these two fault classifications (located west of trench FT-5 and east of trench FT-13; Plate 1) is relatively well-defined and is based on the following observations. Evaluation of the data collected during our study is discussed below for the Western and Eastern fault zones.

#### **Age Criteria for Activity on the Western Fault Zone**

The Cherry Valley fault between Covington Canyon and the prominent drainage just east of trench FT-13 does not displace well developed Bt and K horizon soils of trenches FT-13 through FT-16 and FT-18 through FT-20 estimated to have an age of approximately 100,000 years (see data in Appendix B by M. Bornyasz). The fact that the fault is also not expressed in the topography on the extensive late Pleistocene erosional mesa surface in the area of trenches FT-19 and FT-20 is also strong evidence that the fault has not had Holocene activity in this area. Trench FT-7 located in Covington Canyon exposed the contact between the San Timoteo Formation and alluvium. The fault at this location terminates in San Timoteo sediments and does not extend upward into the alluvium. The alluvial contact slopes to the south and may be either tilted by fault activity or, alternatively, the sloping contact may be the result of erosion.

The age of the alluvium at this locality is estimated to be no younger than latest Pleistocene near the bottom of the channel based on the presence of a well-developed soil profile near the ground surface.

### **Age Criteria for Activity on the Eastern Fault Zone**

From the prominent drainage east of trench FT-13 eastward to the property boundary near trench FT-12 the fault lies at or near the base of a scarp that increases in height from approximately 30 feet to over 70 feet. The fault in this area tends to be located near the base of the highly eroded fault scarp or at prominent mid-scarp topographic benches. Older soil horizons (well-developed Bt and K horizons) that, based on their degree of development, are late-Pleistocene in age, exhibit significant disruption by faulting. In particular, the strong Bt and BCk horizons of trenches FT-1, FT-3a, FT-6, FT-6a, and FT-8 are either overridden by San Timoteo sediments or displaced by as much as 5 feet. The origin and relationship of the strong argillic soil horizons that have been disrupted by faulting in the eastern portion of the site have similar characteristics to the unfaulted argillic soils at trenches FT-19 and FT-20, but are significantly thinner. It is possible that these two soils are similar in age and that the faulted soils of the Eastern Fault Zone developed on the same geomorphic surface or older paleo-slope as the unfaulted soils occupying the mesa surface in the area of trenches FT-19 and FT-20 in the Western Fault Zone.

The contact between younger valley alluvium (estimated minimum age of approximately 5000 years (Bornyasz, Appendix B) and San Timoteo Formation present in trenches FT-4 and FT-6 is not displaced indicating that the fault has not been active since at least mid-Holocene. Early Holocene faulting, however, cannot be ruled out because slightly older sediments with ages closer to the Holocene/Pleistocene boundary are not present. Therefore, setbacks for habitable structures are recommended.

## **STRUCTURAL FAULT SETBACKS**

### **Recommended Structural Fault Setbacks**

The location of the fault as shown on Plate 1 is based on surveying performed by Van Dell and Associates, Inc. Trench and fault locations were surveyed. This survey data was used in conjunction with all geologic data collected to provide a relatively accurate location of the fault throughout the site. Based on our evaluation of the existing fault data collected within the site, it is our professional opinion that structural fault setbacks are prudent for the Cherry Valley fault within the property. We are recommending special setback criteria for the Eastern and Western fault zones based on our assessment regarding the variation of activity along the fault. Our recommended setback criteria for each of these zones are discussed in the following two sections.

We recommended that the setback zone on the hanging wall (north side of the fault) be at least 150 feet wide and the setback on the footwall (area on the south side of the fault) be a minimum of 75 feet. These setbacks should be measured from the location of the mapped trace of the main strand of the fault shown on Figures 4 through 7. However, please see the section below called "Movement of Structural Setbacks Due to Grading" regarding how the recommended setbacks will shift due to grading across the site (i.e. cuts and fills).

The reason for our recommended variance in setback width north and south of the main fault is that the sediments of the San Timoteo formation north of the main fault are generally highly disturbed by faulting and likely to contain secondary faults. In contrast, the sediments of the San Timoteo Formation on the south side of the fault are much less affected by faulting (generally exhibit regional dips) and do not typically exhibit minor faults.

### **Recommended Structural Setbacks for the Western Fault Zone**

No structural setbacks are recommended for residential structures along the western portion of the fault as shown on Figures 4 through 7, and Plate 1. However, faults setbacks as discussed in previous section “Recommended Structural Fault Setbacks” will apply for schools and other public buildings (fire station, post office, etc) along this portion of the fault.

### **Recommended Structural Setbacks for the Eastern Fault Zone**

Structural fault setbacks are recommended for all habitable structures for the Eastern Fault Zone as shown on Figures 4 through 7 and Plate 1. Fault setback dimensions as measured from the main fault will follow the guidelines discussed in the previous section called “Recommended Structural Fault Setbacks.” The final location of the fault setbacks, which will shift during grading, will follow the general guidelines discussed in the next section.

### **Movement of Structural Setbacks Due to Grading.**

A graphic example of the recommended setbacks is depicted on Figure 3. From this figure it can be observed that because the fault plane is tilted toward the north, the final as-graded location of the fault will vary depending on the elevation of finish grades. In general, cutting or lowering the grade over the fault will result in the fault location (and setbacks) migrating toward the north at a ratio of approximately 2:1 (i.e., the fault location will move northward approximately 2 feet for each foot of cut.). In a similar manner, in areas to be filled, the fault’s projected location at finish grade will be located south of its location in the underlying bedrock depicted on Figures 4-7. The fault setback should also satisfy the criteria that the original surface fault location as currently shown on Figures 4-7 should exist within 25 feet of the final fault setback. For example, if local grading cuts “move” the fault toward the north approximately 75 feet in the horizontal, then, the fault setback along the southern side of the fault would need to be widened by approximately 25 feet. In this example, cuts would need to be approximately 130 feet deep (assuming a dip angle of 30 degrees for the fault).

**CLOSURE**

This report has been prepared exclusively for Fiesta Development, Inc. and represents our best professional judgment regarding the location and activity of the Cherry Valley Fault that traverses through the site. It should be realized that the Cherry Valley Fault probably extends a short distance to the west before it dies out. This extension is shown as a dotted line based on weak geomorphic evidence and geologic mapping. In the event that schools or other public buildings are planned in the near vicinity of this fault projection, our firm should be contacted to perform additional services.

We hope that this information meets with your needs at this time. Please feel free to contact the undersigned should you have any questions.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

HUSHMAND AND ASSOCIATES, INC.

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## *APPENDIX A*

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### *References Cited*



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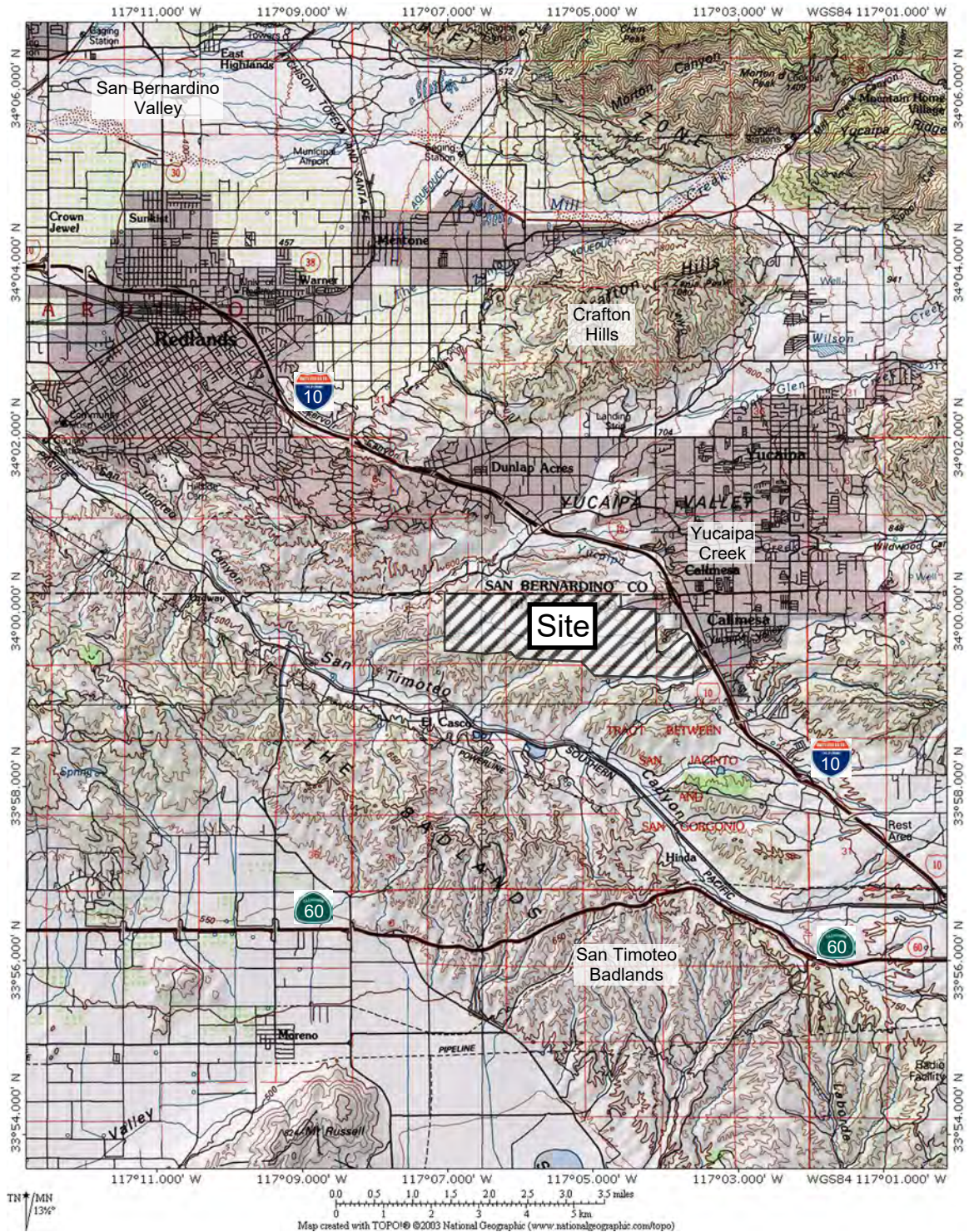
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SAN DIEGO    MURRIETA    LOS ANGELES    COSTA MESA

**SITE LOCATION MAP**

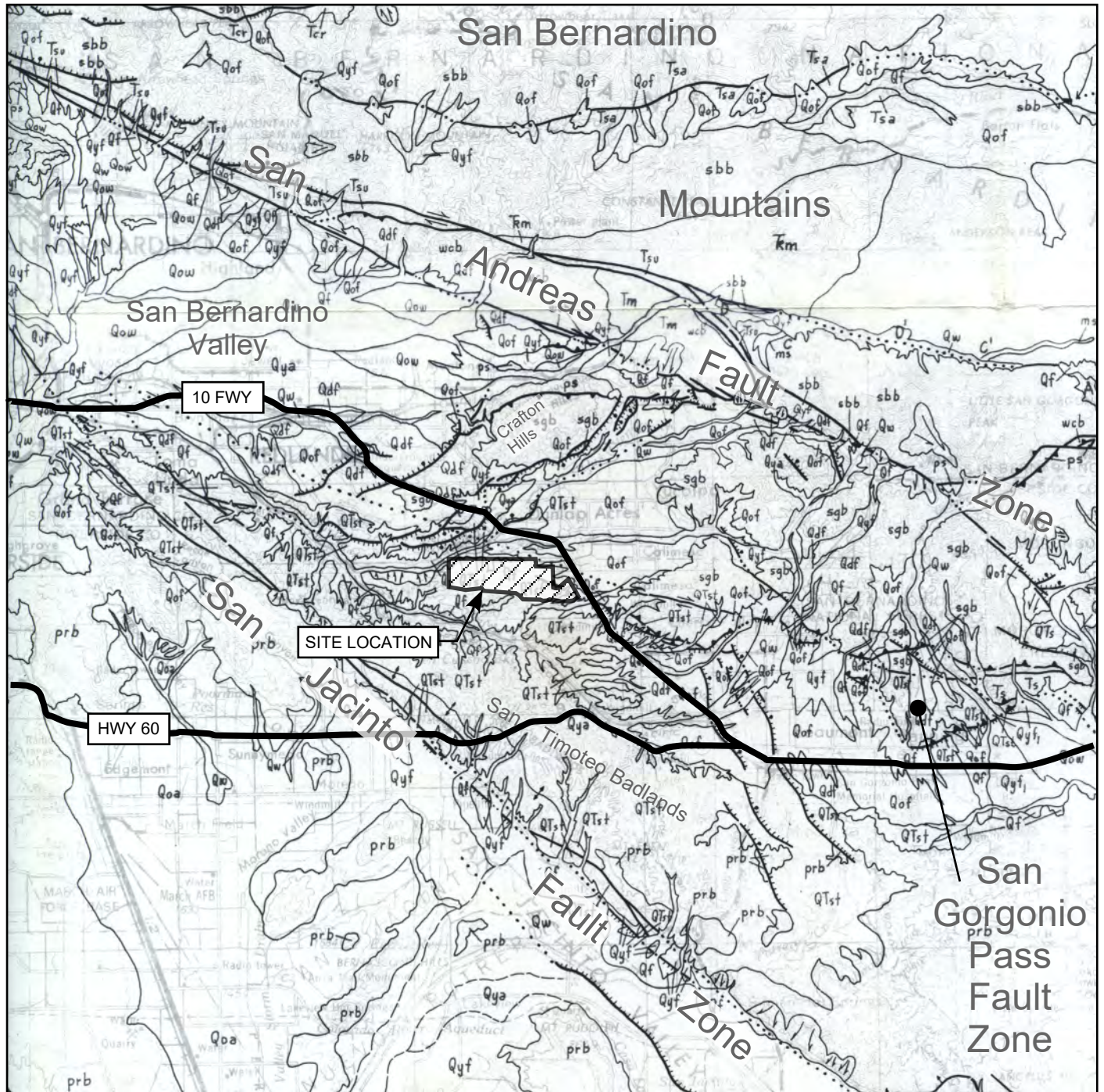
Fiesta Development  
 Calimesa, CA

DATE: 10/2004    J.N.: 238-04

DWG. BY: DBS    SCALE: 1" = 2 miles

**FIGURE 1**





BASE MAP: Matti, J.C., Morton, D.M., and Cox, B.F., The San Andreas Fault System in the Vicinity of the Central Transverse Ranges Province, Southern California, Sheet 2, OFR 92-356 (1992).

**EXPLANATION**



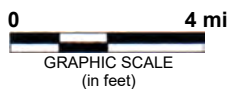
Modern Alluvial Fan Deposits - Quaternary



San Timoteo Badlands Deposits - Pleistocene to Pliocene



Thrust Fault



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**REGIONAL GEOLOGIC MAP**

Fiesta Development  
Calimesa, CA

DATE: 10/2004

J.N.: 238-04

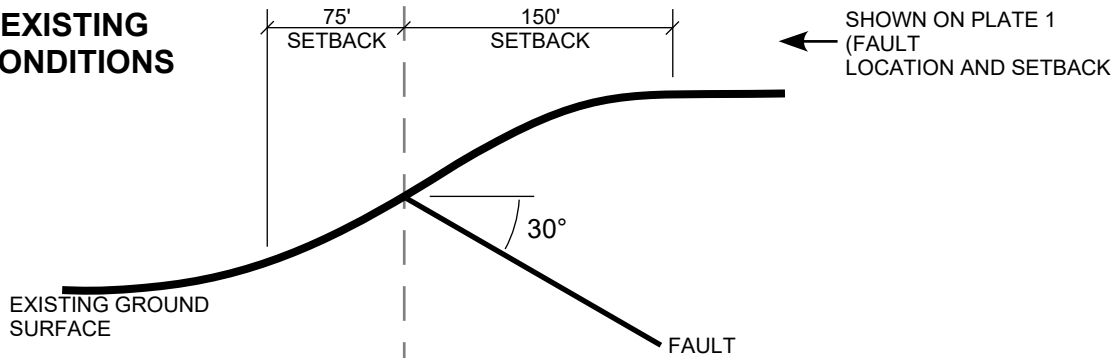
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SCALE: 1" = 4 miles

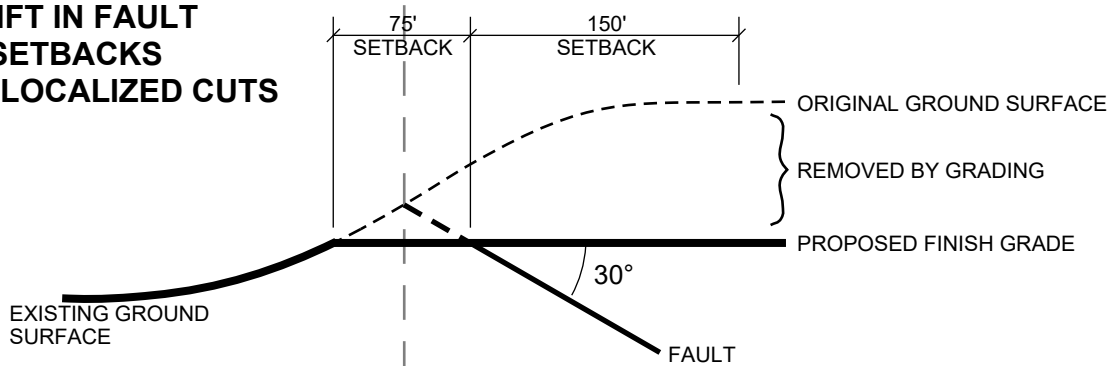
**FIGURE 2**

VIEW TO THE WEST  
(NOT TO SCALE)

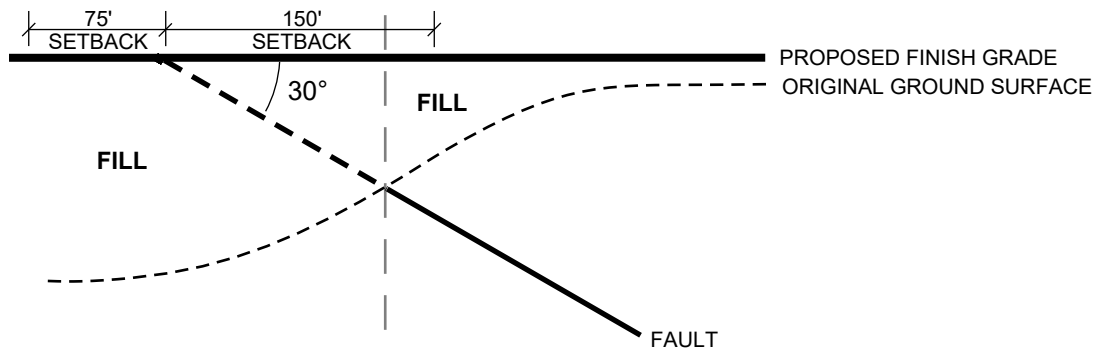
**EXISTING  
CONDITIONS**



**SHIFT IN FAULT  
SETBACKS  
DUE TO LOCALIZED CUTS**



**SHIFT IN FAULT  
SETBACKS  
DUE TO LOCALIZED FILL**



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**SHIFT OF FAULT SETBACKS  
DUE TO GRADING**

Fiesta Development  
Calimesa, CA

DATE: 10/2004

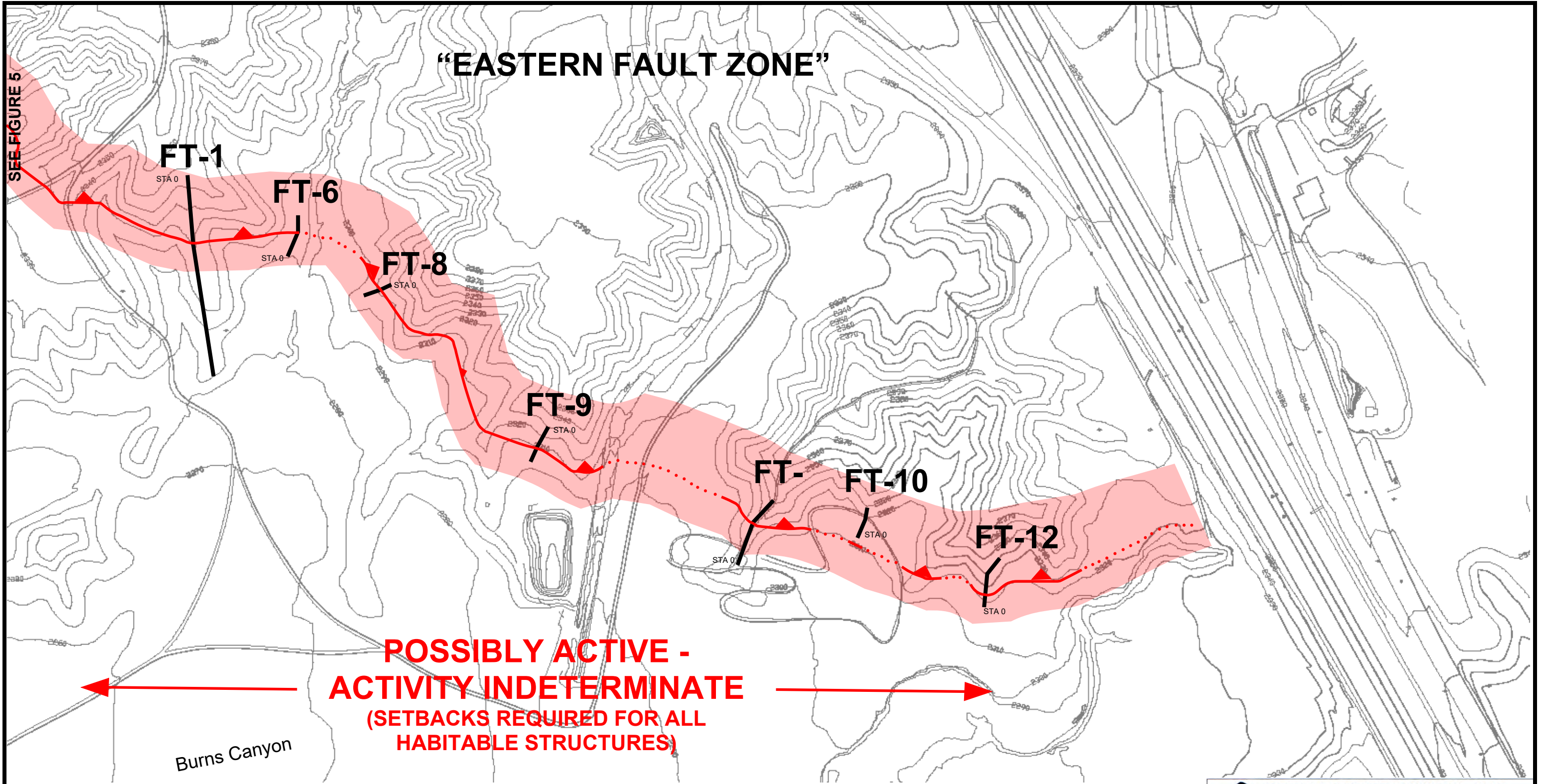
J.N.: 238-04

DWG. BY: DBS

SCALE: NO SCALE

**FIGURE 3**

# "EASTERN FAULT ZONE"



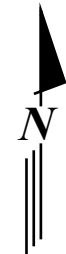
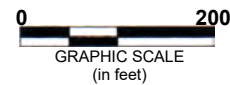
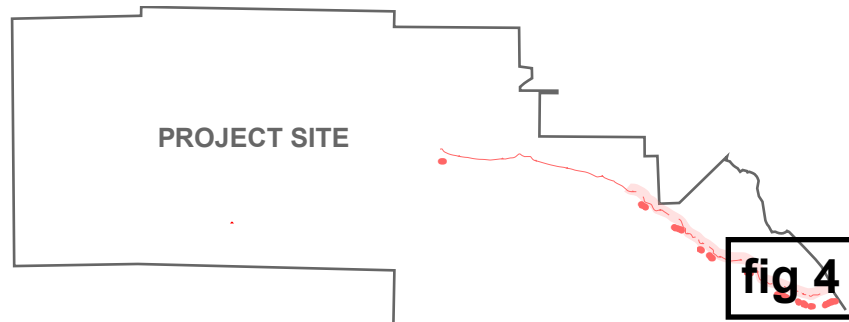
**POSSIBLY ACTIVE -  
ACTIVITY INDETERMINATE**  
(SETBACKS REQUIRED FOR ALL  
HABITABLE STRUCTURES)

BASE MAP: Oak Valley Topo Map, Van Dell and Associates

### EXPLANATION

Approximate Fault Location, Dotted Where Buried: Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates Approximate Setback from Fault

**FT-12**  
Approximate Location of Fault Trench; STA 0 Indicates Trench Orientation Relative to Fault Trench Logs



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LOS ANGELES		COSTA MESA	
<b>GEOTECHNICAL MAP</b>			
Fiesta Development Calimesa, CA			
DATE:	10/2004	J.N.:	238-04
DWG. BY:	DBS	SCALE:	1" = 200'
			<b>FIGURE 4</b>

SEE FIGURE 6

# "WESTERN FAULT

## FT-13



**POTENTIALLY ACTIVE**  
(NO SETBACKS REQUIRED FOR RESIDENTIAL STRUCTURES. SETBACKS REQUIRED FOR SCHOOLS AND/OR PUBLIC STRUCTURES)

# "EASTERN FAULT ZONE"

## FT-5



**POSSIBLY ACTIVE - ACTIVITY INDETERMINATE**  
(SETBACKS REQUIRED FOR ALL HABITABLE STRUCTURES)

## FT-3a

## FT-4

## FT-17

## FT-1

## FT-6

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### GEOTECHNICAL MAP

Fiesta Development  
Calimesa, CA

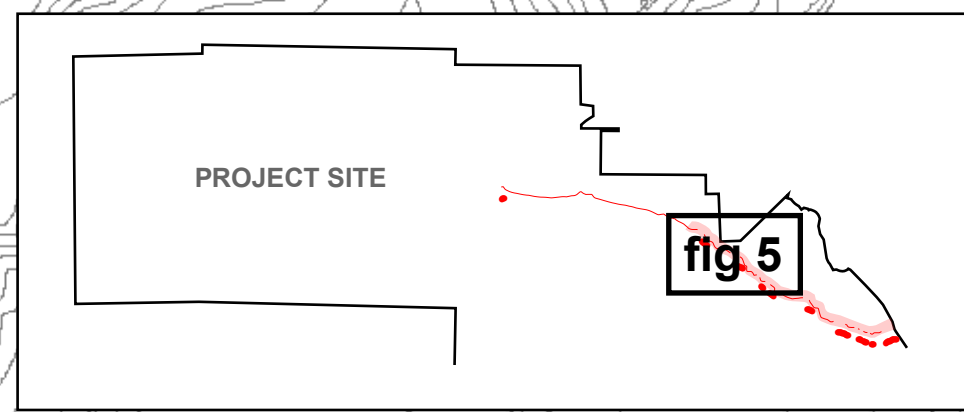
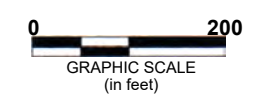
DATE:	10/2004	J.N.:	238-04	<b>FIGURE 5</b>
DWG. BY:	DBS	SCALE:	1" = 200'	

### EXPLANATION

Approximate Fault Location, Dotted Where Buried: Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates Approximate Setback from Fault

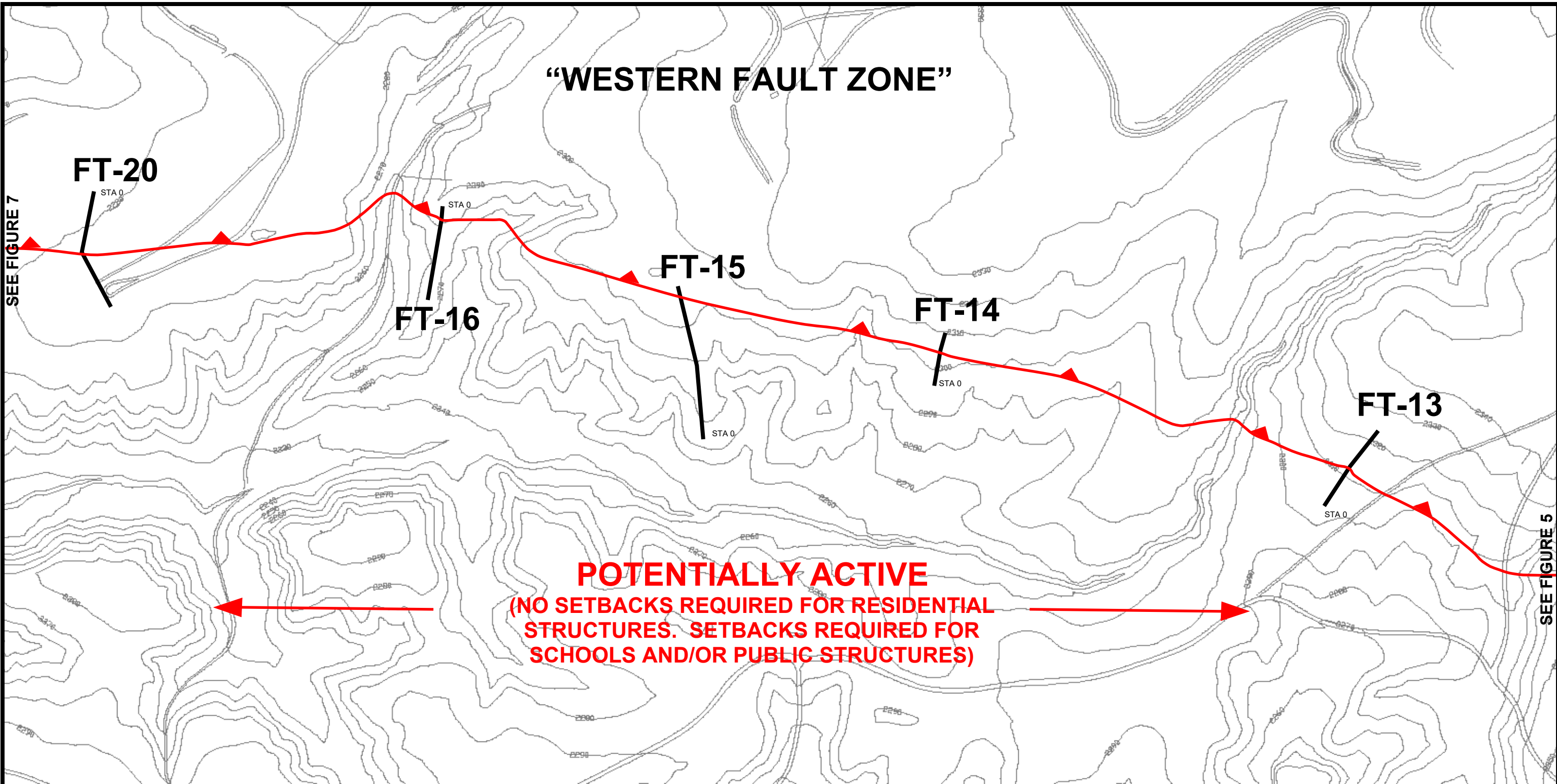
**FT-17**  
Approximate Location of Fault Trench; STA 0 Indicates Trench Orientation Relative to Fault Trench Logs

BASE MAP: Oak Valley Topo Map, Van Dell and Associates




SEE FIGURE 4


# "WESTERN FAULT ZONE"

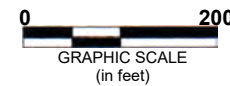
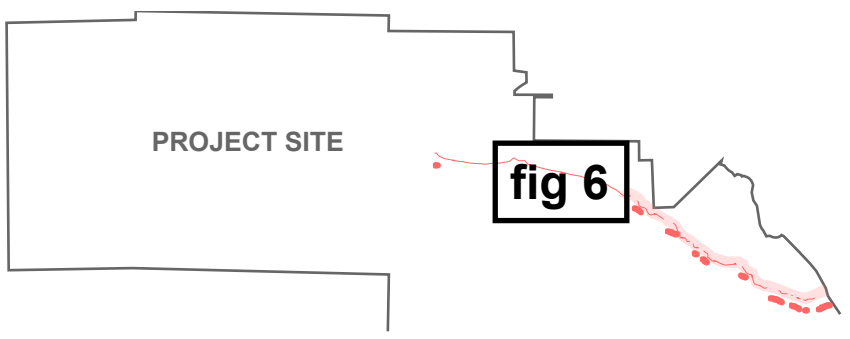


BASE MAP: Oak Valley Topo Map, Van Dell and Associates

## EXPLANATION

 Approximate Fault Location, Dotted Where Buried, Queried Where Uncertain: Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates Approximate Setback from Fault

 **FT-20**  
Approximate Location of Fault Trench; STA 0 Indicates Trench Orientation Relative to Fault Trench Logs



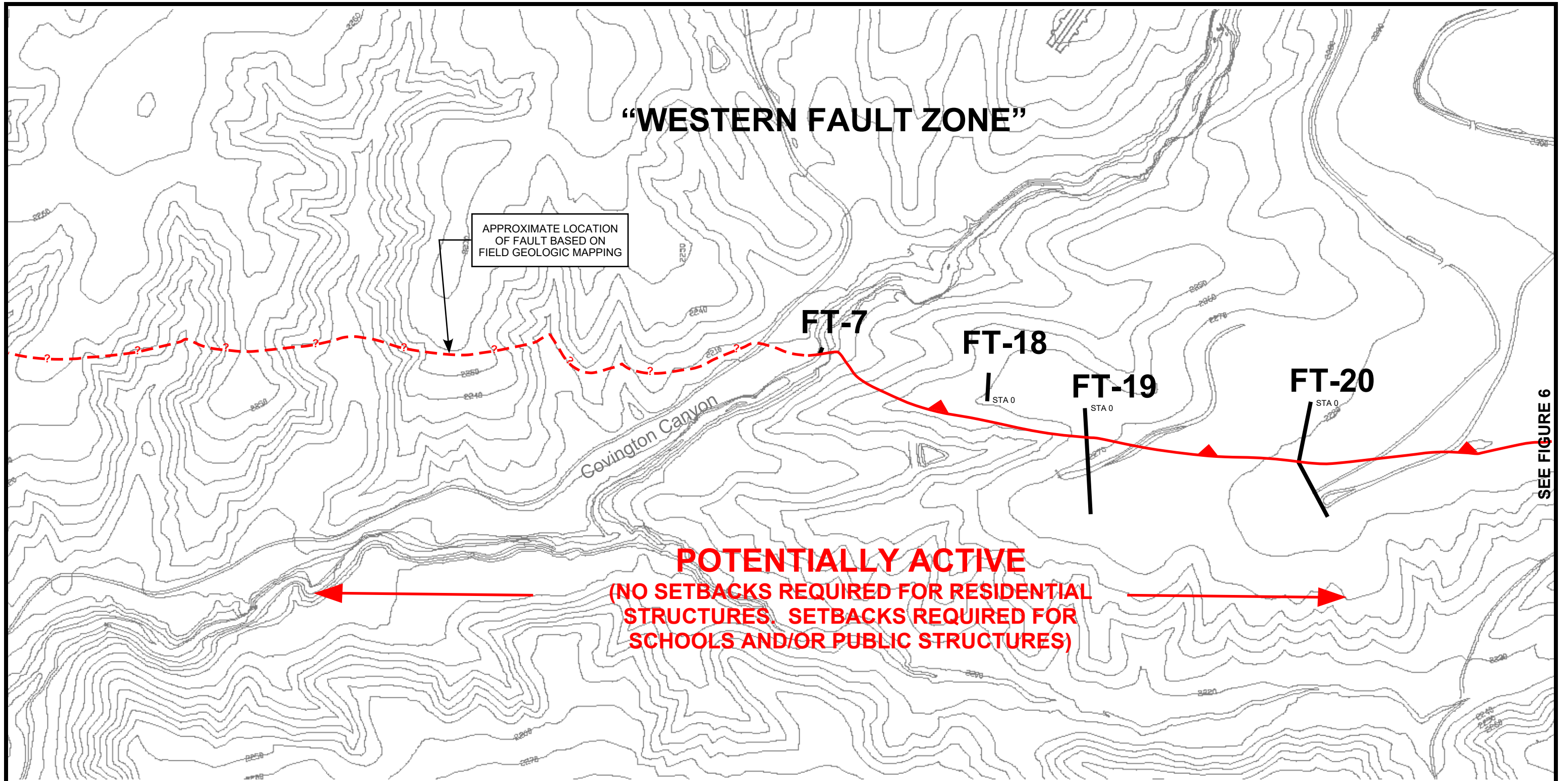
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## GEOTECHNICAL MAP

Fiesta Development  
Calimesa, CA

DATE: 10/2004 J.N.: 238-04  
DWG. BY: DBS SCALE: 1" = 200'


**FIGURE 6**




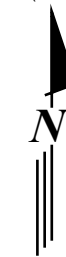
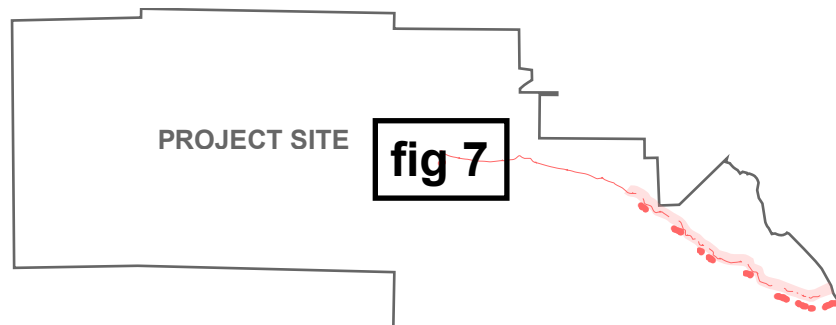
SEE FIGURE 6


BASE MAP: Oak Valley Topo Map, Van Dell and Associates

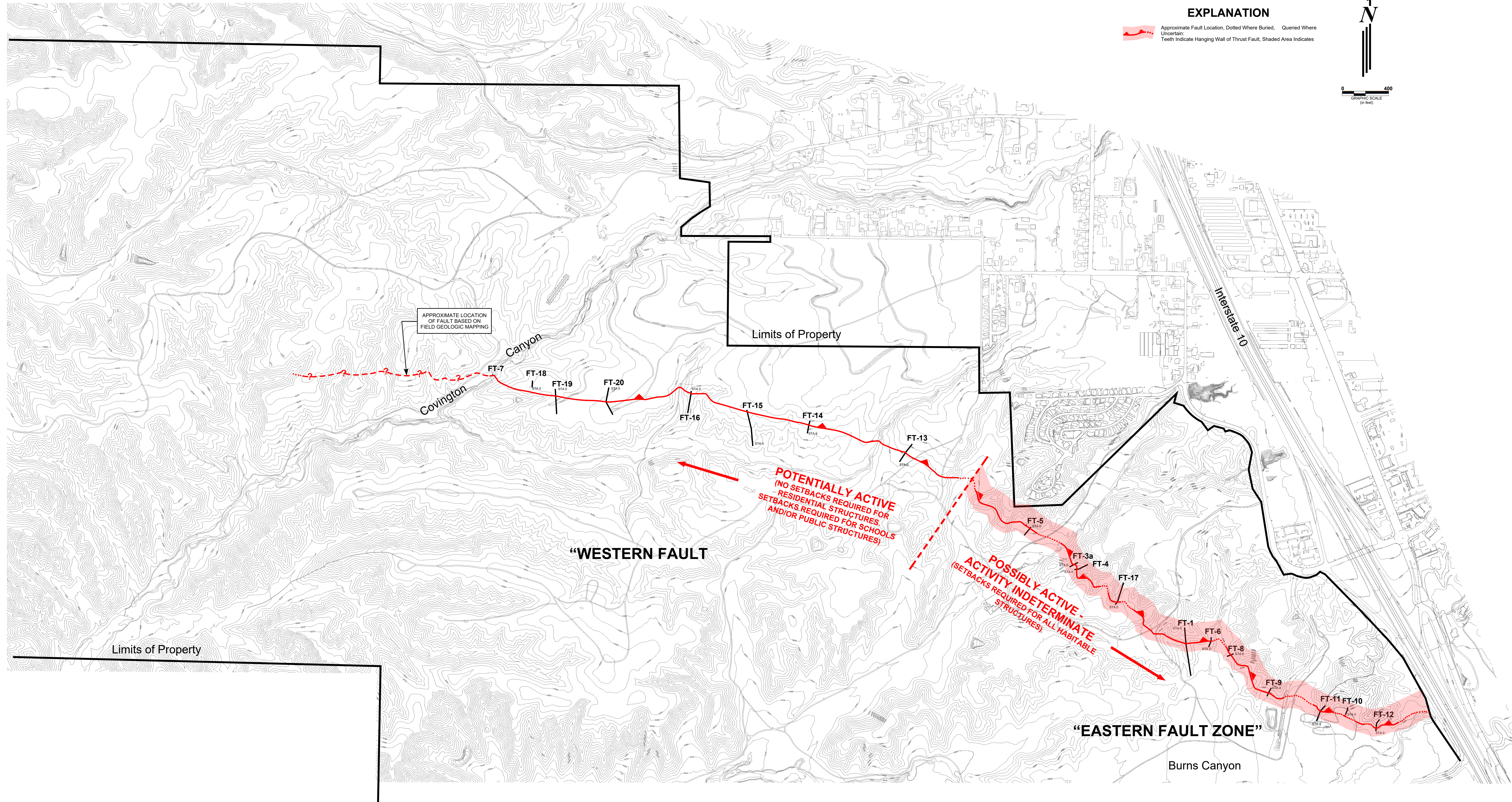
**EXPLANATION**

 Approximate Fault Location, Dotted Where Buried, Queried Where Uncertain; Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates Approximate Setback from Fault

 **FT-20**  
Approximate Location of Fault Trench; STA 0 Indicates Trench Orientation Relative to Fault Trench Logs

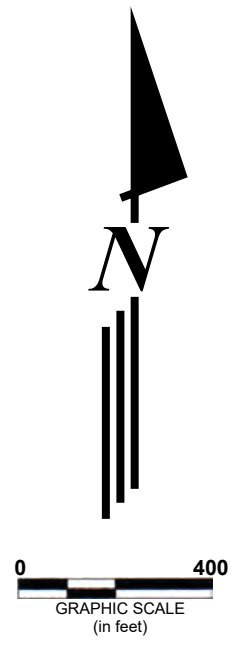


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<b>GEOTECHNICAL MAP</b>		
Fiesta Development Calimesa, CA		
DATE:	10/2004	J.N.: 238-04
DWG. BY:	DBS	SCALE: 1" = 200'
		FIGURE 7



**EXPLANATION**

Approximate Fault Location, Dotted Where Buried, Queried Where Uncertain.  
 Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates



APPROXIMATE LOCATION OF FAULT BASED ON FIELD GEOLOGIC MAPPING

Limits of Property

Covington Canyon

FT-7

FT-18

FT-19

FT-20

FT-16

FT-15

FT-14

FT-13

**POTENTIALLY ACTIVE**  
 (NO SETBACKS REQUIRED FOR RESIDENTIAL STRUCTURES. SETBACKS REQUIRED FOR SCHOOLS AND/OR PUBLIC STRUCTURES)

**"WESTERN FAULT"**

**POSSIBLY ACTIVE - ACTIVITY INDETERMINATE**  
 (SETBACKS REQUIRED FOR ALL HABITABLE STRUCTURES)

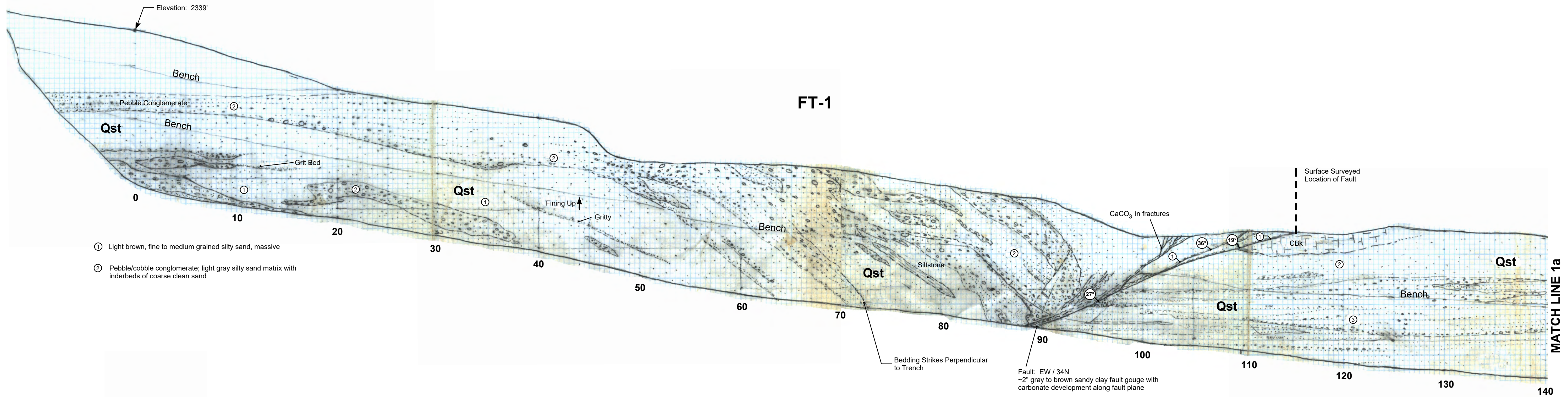
**"EASTERN FAULT ZONE"**

Burns Canyon

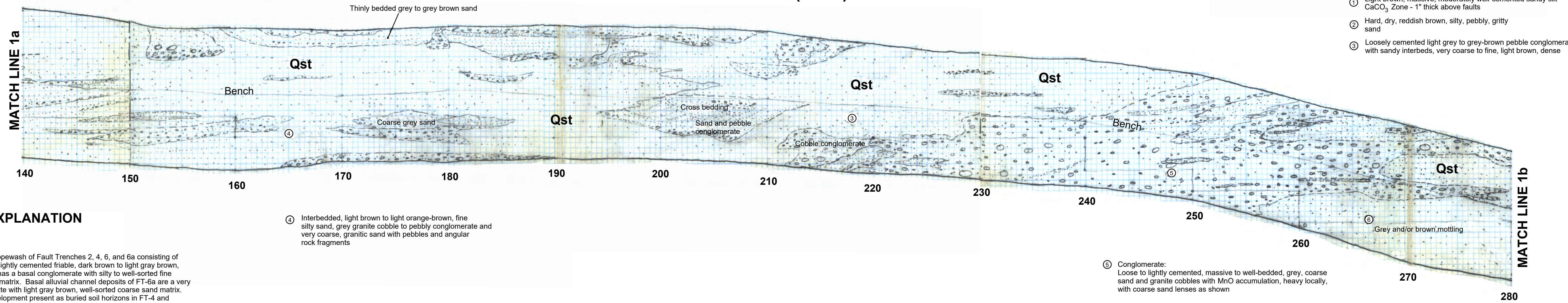
Interstate 10

Limits of Property

<b>PETRA GEOTECHNICAL, INC.</b> <small>1222 WORLD TRADE DRIVE, SUITE 9        SAN DIEGO, CALIFORNIA 92128        PHONE: (619) 461-6300</small>			
SAN DIEGO	MURIELTA	LOS ANGELES	COSTA MESA
<b>GEOTECHNICAL MAP</b>			
Fiesta Development Calimesa, CA			
DATE	10/2004	J.N.	238-04
DWG BY:	DBS	SCALE:	1" = 400'
			<b>PLATE 1</b>



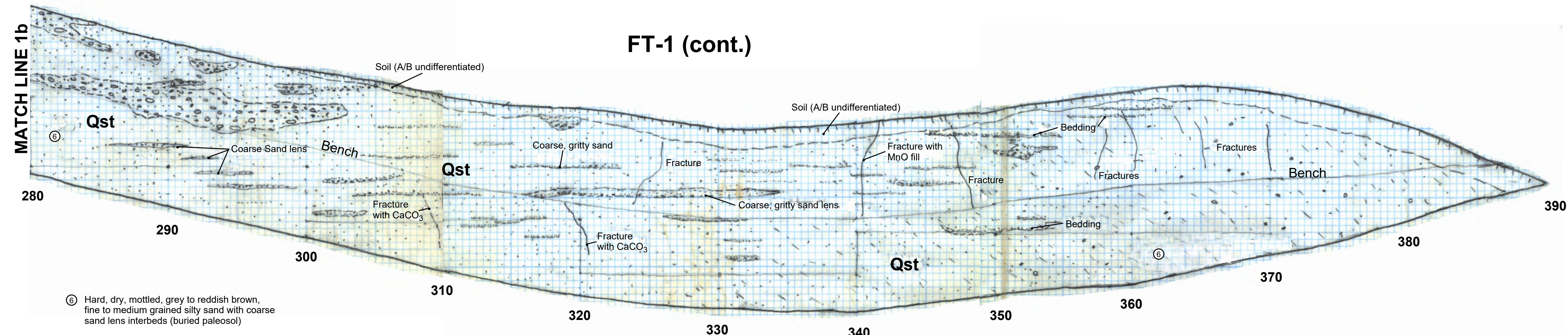
FT-1 (cont.)



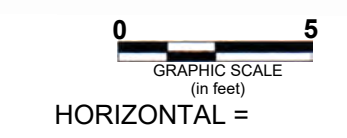
④ Interbedded, light brown to light orange-brown, fine silty sand, grey granite cobble to pebbly conglomerate and very coarse, granitic sand with pebbles and angular rock fragments

⑤ Conglomerate: Loose to lightly cemented, massive to well-bedded, grey, coarse sand and granite cobbles with MnO accumulation, heavy locally, with coarse sand lenses as shown

FT-1 (cont.)



⑥ Hard, dry, mottled, grey to reddish brown, fine to medium grained silty sand with coarse sand lens interbeds (buried paleosol)



**FT-1**

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**FAULT TRENCH EXPLORATION**  
 Fiesta Development  
 Calimesa, CA

DATE: 10/20/04 J.N. 238-04  
 DWG BY: DBS SCALE: 1" = 5' **PLATE 2**

**EXPLANATION**

- HOLOCENE VALLEY ALLUVIUM**
- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
  - Qal<sub>S2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine- to medium-grained sand and sandy clay.
  - Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
  - Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.
- LATE PLEISTOCENE PEDOGENIC SOILS**
- A** A horizon; loose, dry, gray brown silty organic
  - Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
  - Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
  - Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
  - K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
  - CBk** This horizon is transitional between slightly weathered parent material and more weathered Btk horizons. In FT-6 the CBk horizon grades laterally to a white K horizon.
  - CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
  - Kr** Krotovina (filled animal burrows).
- PLEISTOCENE BEDROCK**
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with local paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and characterized by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.

**EXPLANATION**

**HOLOCENE VALLEY ALLUVIUM**

- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-5 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
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**LATE PLEISTOCENE PEDOGENIC SOILS**

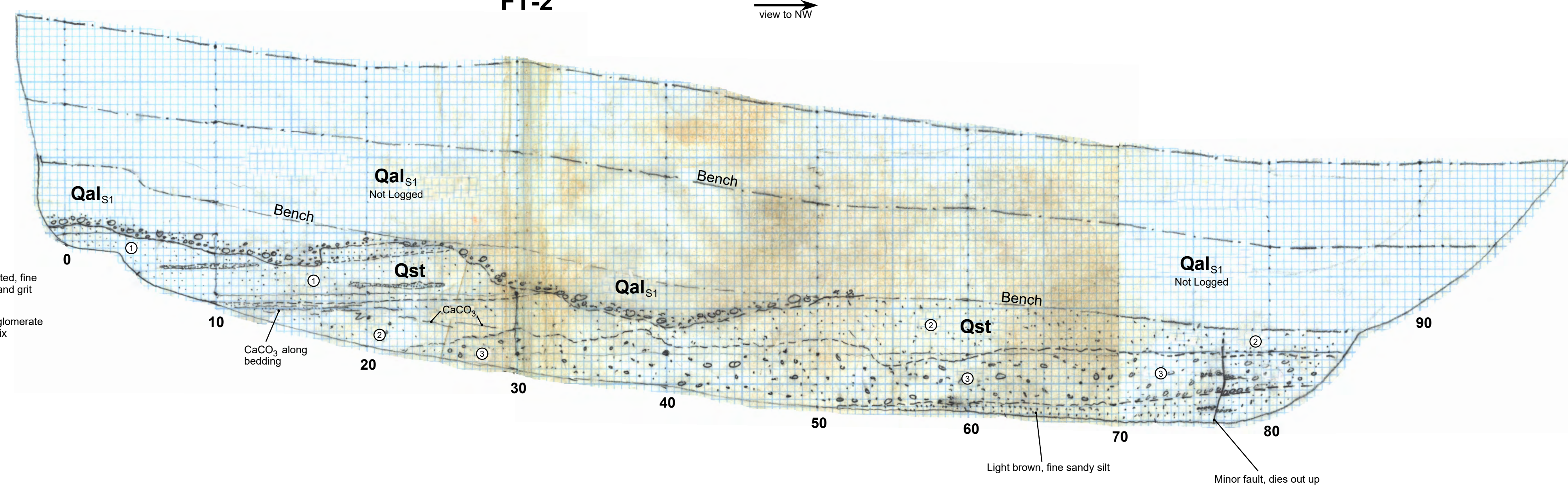
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- Kr** Krotovina (filled animal burrows).

**PLEISTOCENE BEDROCK**

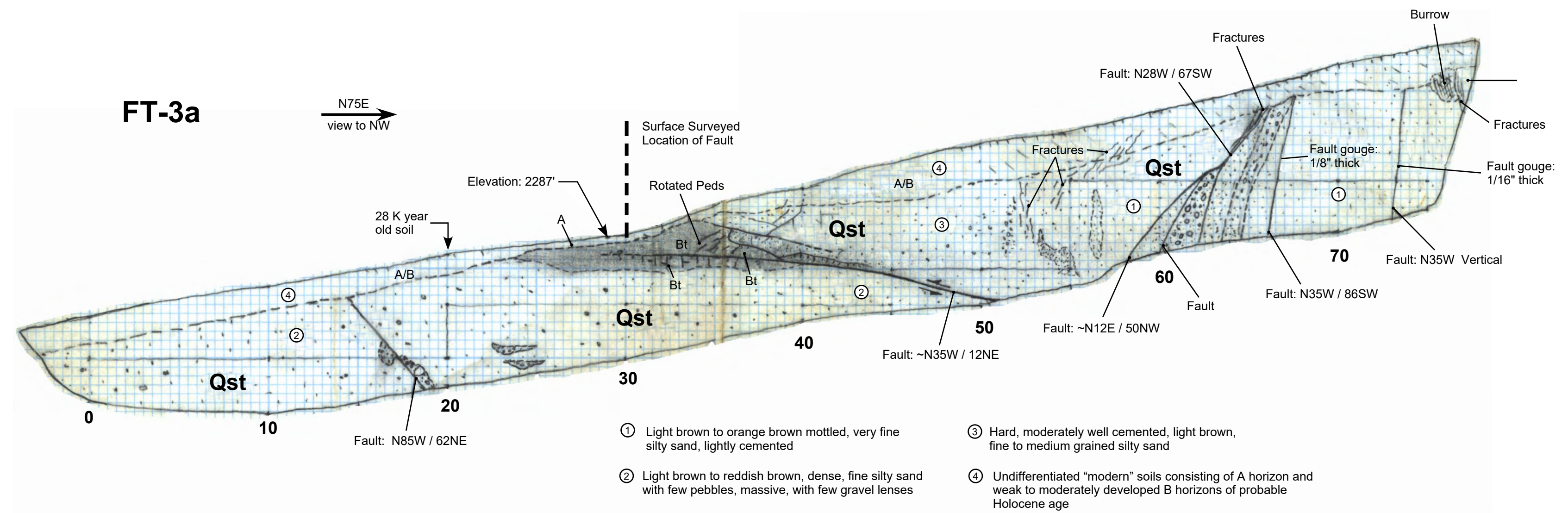
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.

**FT-2**  
N65E  
view to NW

- ① Slightly cemented, light brown very fine silty sand, massive
- ② Light brown, moderately well-cemented, fine grained silty sand with few pebbles and grit
- ③ Dense, dry, light brown pebble conglomerate with medium grained silty sand matrix

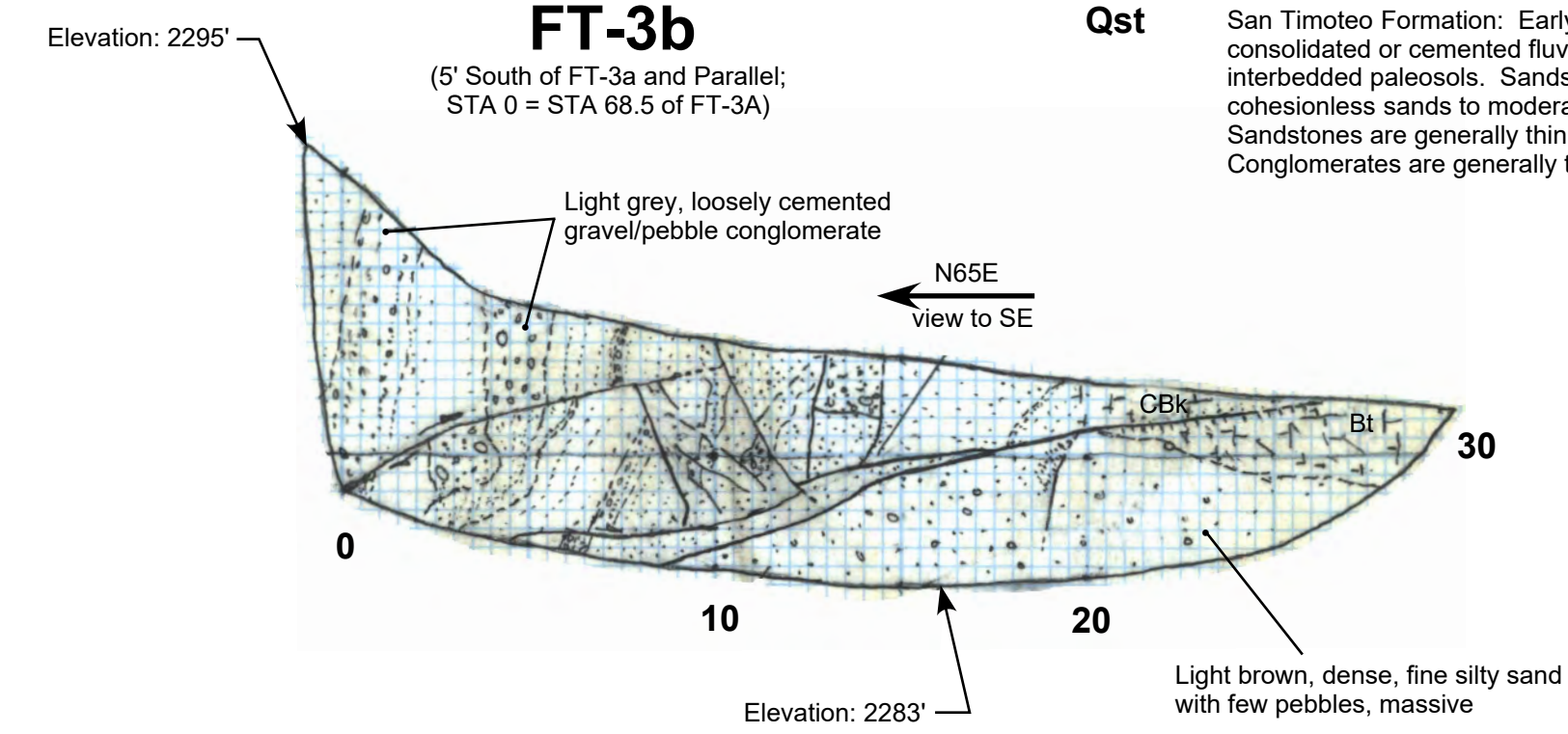


**FT-3a**  
N75E  
view to NW

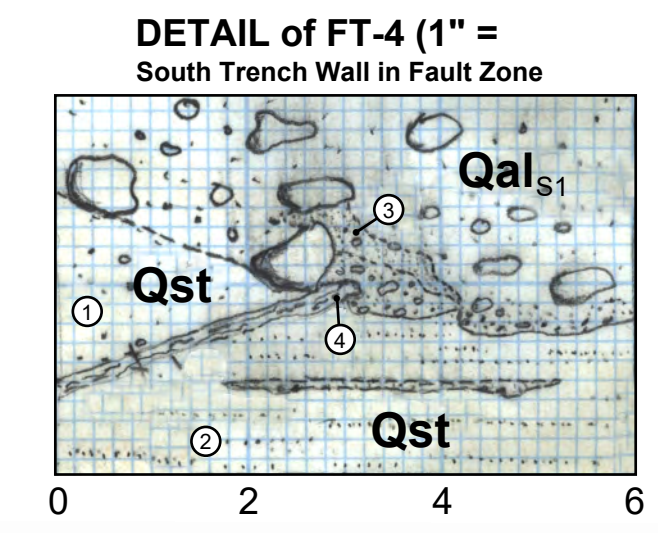


- ① Light brown to orange brown mottled, very fine silty sand, lightly cemented
- ② Light brown to reddish brown, dense, fine silty sand with few pebbles, massive, with few gravel lenses
- ③ Hard, moderately well cemented, light brown, fine to medium grained silty sand
- ④ Undifferentiated "modern" soils consisting of A horizon and weak to moderately developed B horizons of probable Holocene age

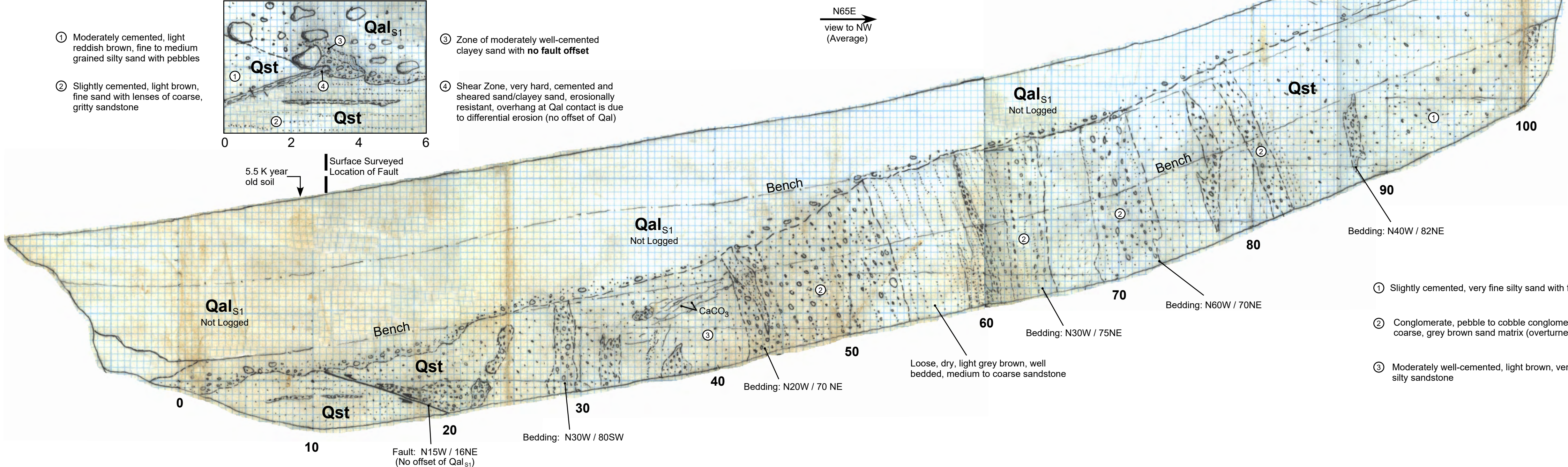
**FT-3b**  
(5' South of FT-3a and Parallel; STA 0 = STA 68.5 of FT-3A)  
N65E  
view to SE



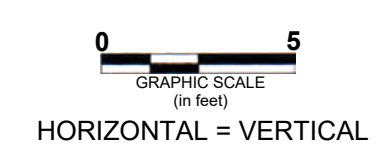
**FT-4**



- ① Moderately cemented, light reddish brown, fine to medium grained silty sand with pebbles
- ② Slightly cemented, light brown, fine sand with lenses of coarse, gritty sandstone
- ③ Zone of moderately well-cemented clayey sand with **no fault offset**
- ④ Shear Zone, very hard, cemented and sheared sand/clayey sand, erosionally resistant, overhang at Qal contact is due to differential erosion (no offset of Qal)



- ① Slightly cemented, very fine silty sand with few pebbles and grit
- ② Conglomerate, pebble to cobble conglomerate with coarse, grey brown sand matrix (overturned throughout trench)
- ③ Moderately well-cemented, light brown, very fine silty sandstone

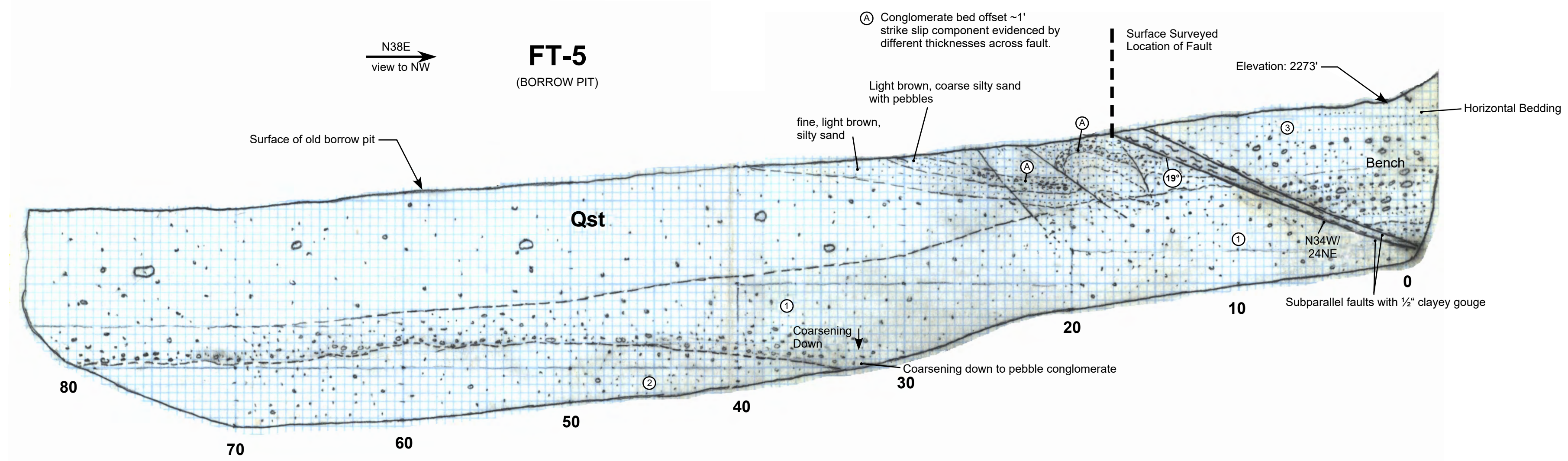


**FT-2 thru FT-**

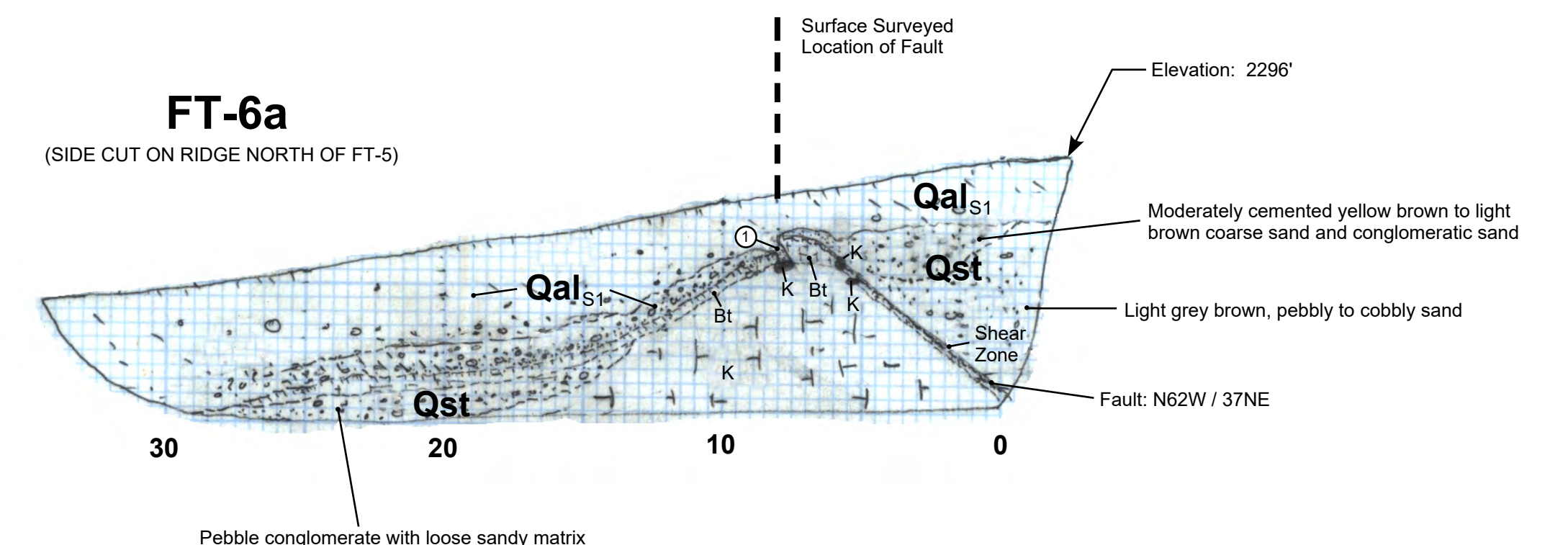
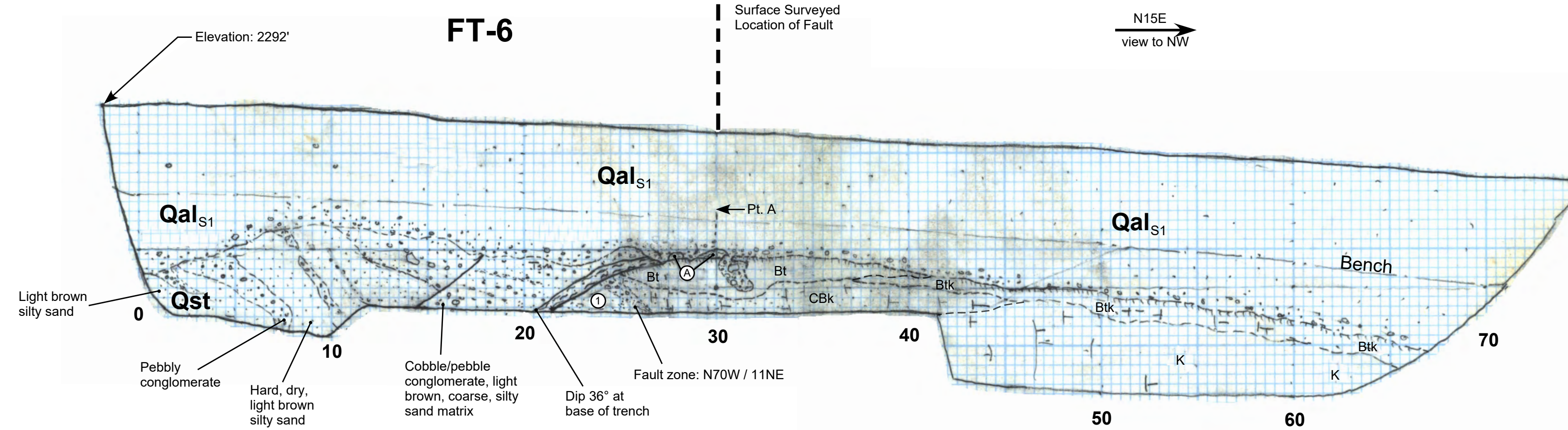
**PETRA GEOTECHNICAL, INC.**  
1225 WORLD TRADE DRIVE, SUITE P  
SAN DIEGO, CALIFORNIA 92128  
SAN DIEGO MURETTA LOS ANGELES COSTA MESA  
PHONE: (858) 485-6000

**FAULT TRENCH EXPLORATION LOGS**  
Fiesta Development  
Calimesa, CA

DATE: 10/2004 J.N. 238-04  
DWG BY: DBS SCALE: 1" = 5' **PLATE 3**



- ① Very dense, damp, light reddish brown, silty, medium grained with scattered pebbles, massive
- ② Lightly cemented, massive, light reddish brown, fine silty sand with few pebbles
- ③ Loose to lightly cemented, grey brown to light grey, coarse sand and interbedded pebble conglomerate



NOTE:  
 ① Vertical and lateral separation of Bt horizon with ~1.5' horizontal separation with infill of silty sand, lateral separation with overhanging Bt that is not eroded with infill of modern Qsw, good evidence of recent fault activity.

**EXPLANATION**

**HOLOCENE VALLEY ALLUVIUM**

- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
- Qal<sub>S2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
- Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
- Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.

**LATE PLEISTOCENE PEDOGENIC SOILS**

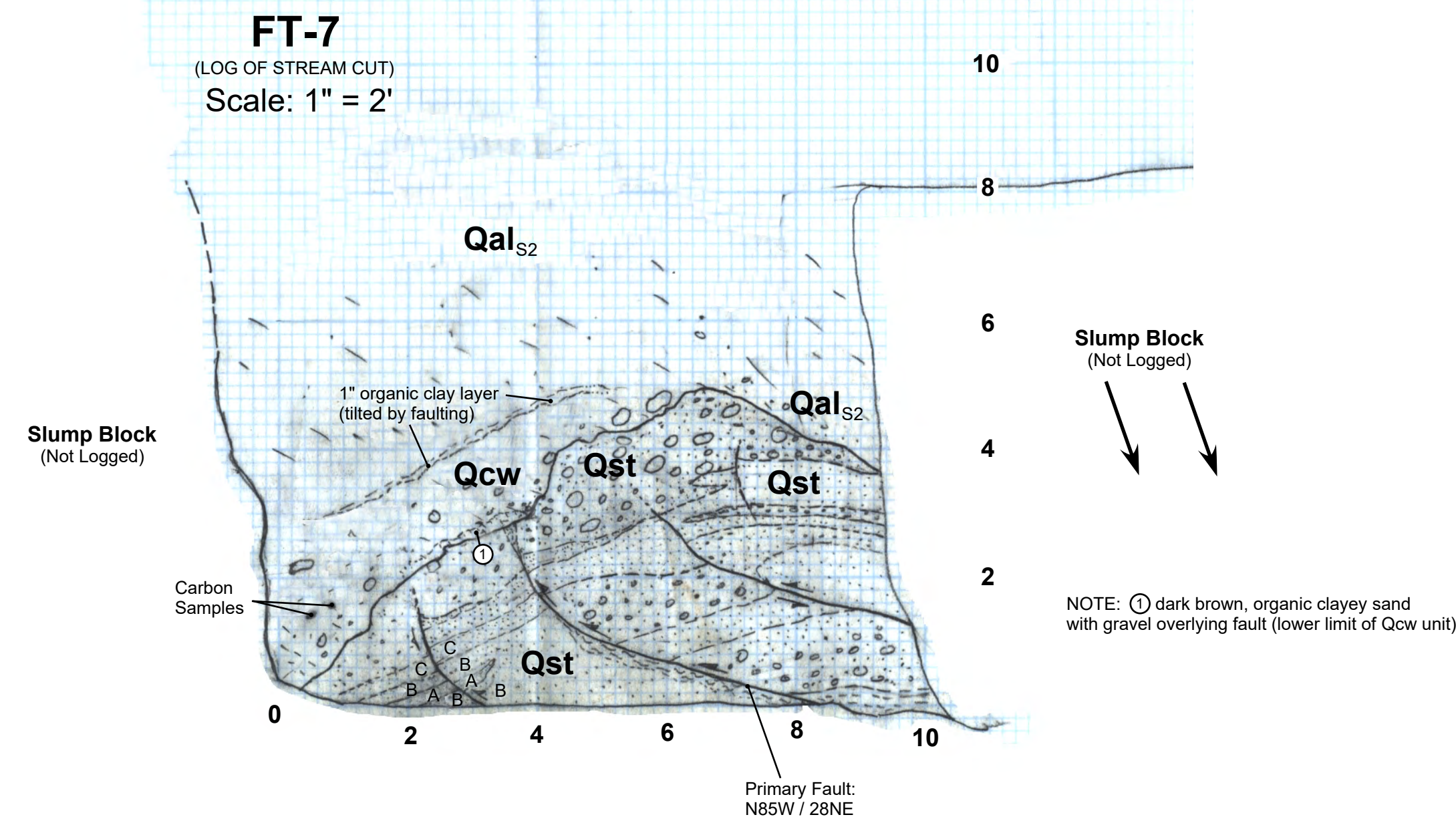
- A** A horizon; loose, dry, gray brown silty organic sand
- Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
- Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
- Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
- K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
- CBk** This horizon is transitional between slightly weathered parent material and more weathered Btk horizons. In FT-6 the CBk horizon grades laterally to a white K horizon.
- CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
- Kr** Krotovina (filled animal burrows).

**PLEISTOCENE BEDROCK**

- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.

- Bk** Hard, white carbonate horizon, locally stage II, average stage V ±, developed in hard, brown siltstone, massive
- Bt** argillic horizon, Blocky to prismatic peds with moderately developed clay films
- Qal<sub>S1</sub>** loose, dry, light grey brown, fine silty sand, few pebbles and grit, with cobble/pebble conglomerate at base
- ① Hard, dry, light brown sandy siltstone

NOTE: ② remnant fault shear zone cut by Qal



NOTE: ① dark brown, organic clayey sand with gravel overlying fault (lower limit of Qcw unit)

**FT-5 thru FT-**

**PETRA GEOTECHNICAL, INC.**  
 1225 WORLD TRADE DRIVE, SUITE P  
 SAN DIEGO, CALIFORNIA 92128  
 PHONE: (619) 488-5030

SAN DIEGO MURIELTA LOS ANGELES COSTA MESA

**FAULT TRENCH EXPLORATION LOGS**

Fiesta Development  
 Calimesa, CA

DATE	10/2004	J.N.	238-04
DWG BY:	DBS	SCALE:	1" = 5'

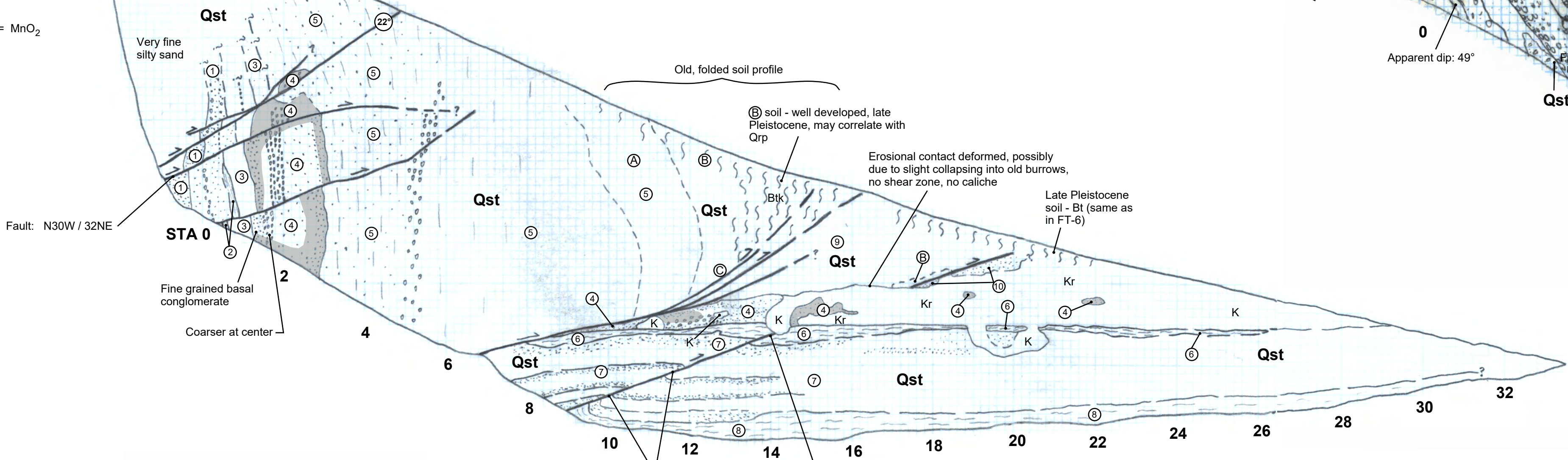
**PLATE 4**

**FT-8**

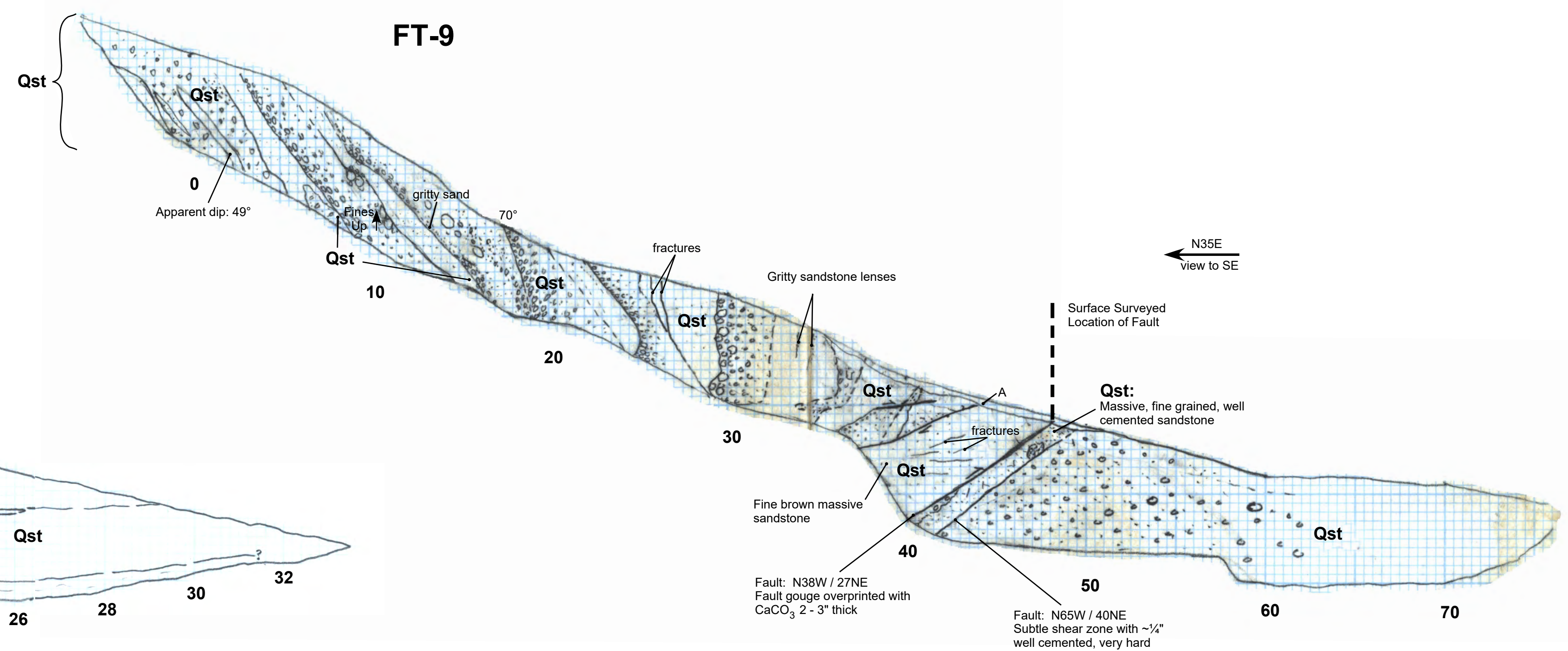
GRAPHIC SCALE  
HORIZONTAL = VERTICAL

■ = MnO<sub>2</sub>

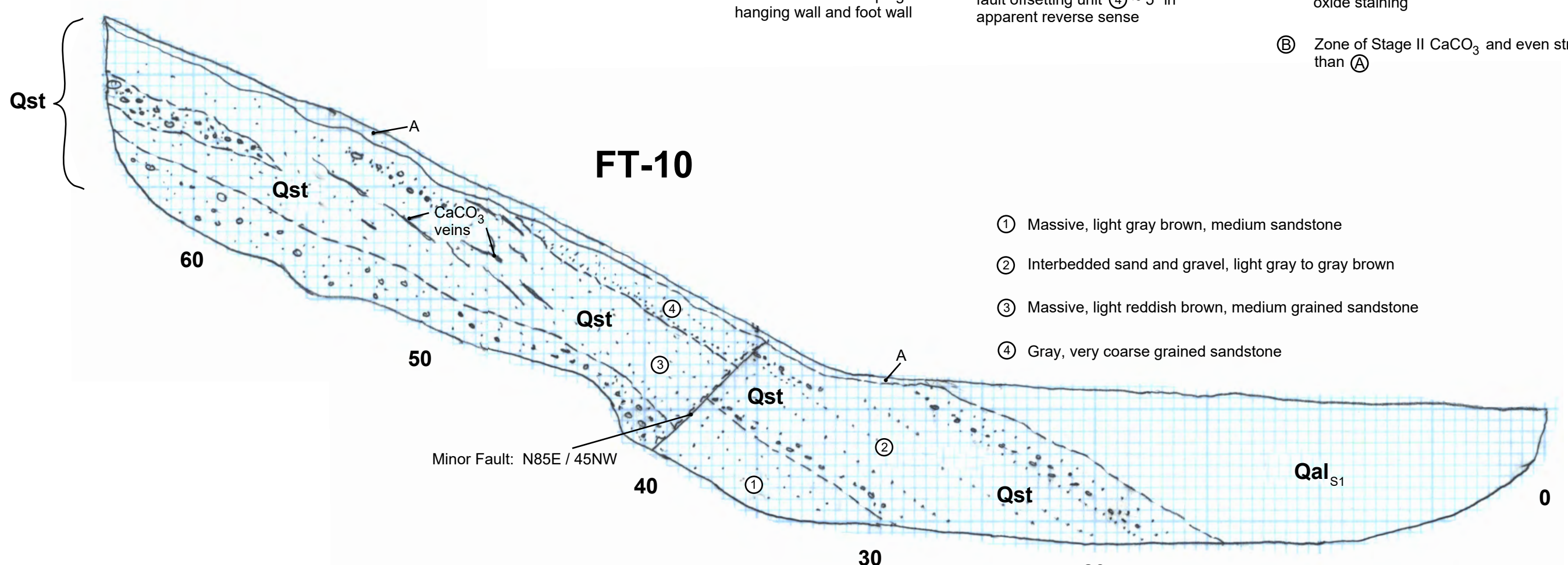
- ① Conglomeratic sand, subrounded pebbles, moderate MnO<sub>2</sub> stain
- ② Fine sand with bedding, moderate MnO<sub>2</sub> staining parallel to bedding
- ③ Silty fine sand, massive, slightly red but mostly tan, similar to unit ①
- ④ Pebbly conglomerate pebbles are subrounded and dominated by leucocratic plutonic clasts with minor gneiss and metamorphic clasts, moderately bedded particularly in lower (North) 4" of unit, gray areas indicate regions with strong MnO<sub>2</sub> staining that coat the grains
- ⑤ Very fine silty sand (SP), light olive brown, massive, some rounded pebbles, same pebble composition as unit ①, moderate FeO<sub>3</sub> staining - penetrative, no MnO<sub>2</sub>, no CaCO<sub>3</sub>
- ⑥ Reddish brown, sandy silt, very fine grained
- ⑦ Reddish brown, medium to abundant very coarse sand, and pebbles, well bedded channel sands, minor MnO<sub>2</sub> staining in zones, but in 3 zones some pebble/grains are completely covered, bedding is approximately horizontal except near fault where it dips gently North, this is unit likely correlates with units ①, ②, and ③
- ⑧ Sandy silt to silty very fine sand, reddish brown in upper 6" of unit, grades to olive brown at depth, bedded, compositional layers are 1 - 3" thick (variations of silt and sand), this unit likely correlates with very fine silty sand member structurally below unit ①
- ⑨ Sandy silt, very fine grained, olive brown, massive, weak soil near surface (B); very little CaCO<sub>3</sub> in unit except where indicated in small area at base of unit below region with soil, very similar to unit ①
- ⑩ Silty sand, fine grained with some coarse sand, medium rust red, altered by animals and near surface soil processes



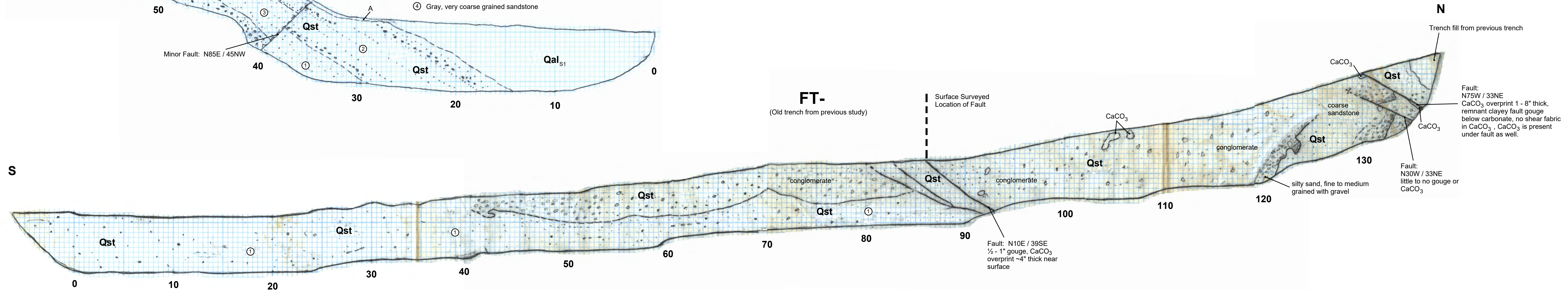
**FT-9**



**FT-10**



**FT-**  
(Old trench from previous study)



**EXPLANATION**

① Dense, moderately cemented, reddish brown, silty sand with few gravels, massive bedding

**HOLOCENE VALLEY ALLUVIUM**

- Qal<sub>s1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
- Qal<sub>s2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
- Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
- Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.

**LATE PLEISTOCENE PEDOGENIC SOILS**

- A** A horizon; loose, dry, gray brown silty organic sand
- Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
- Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
- Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
- K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
- CBk** This horizon is transitional between slightly weathered parent material and more weathered Btk horizons. In FT-6 the CBk horizon grades laterally to a white K horizon.
- CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
- Kr** Krotovina (filled animal burrows).

**PLEISTOCENE BEDROCK**

**Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.

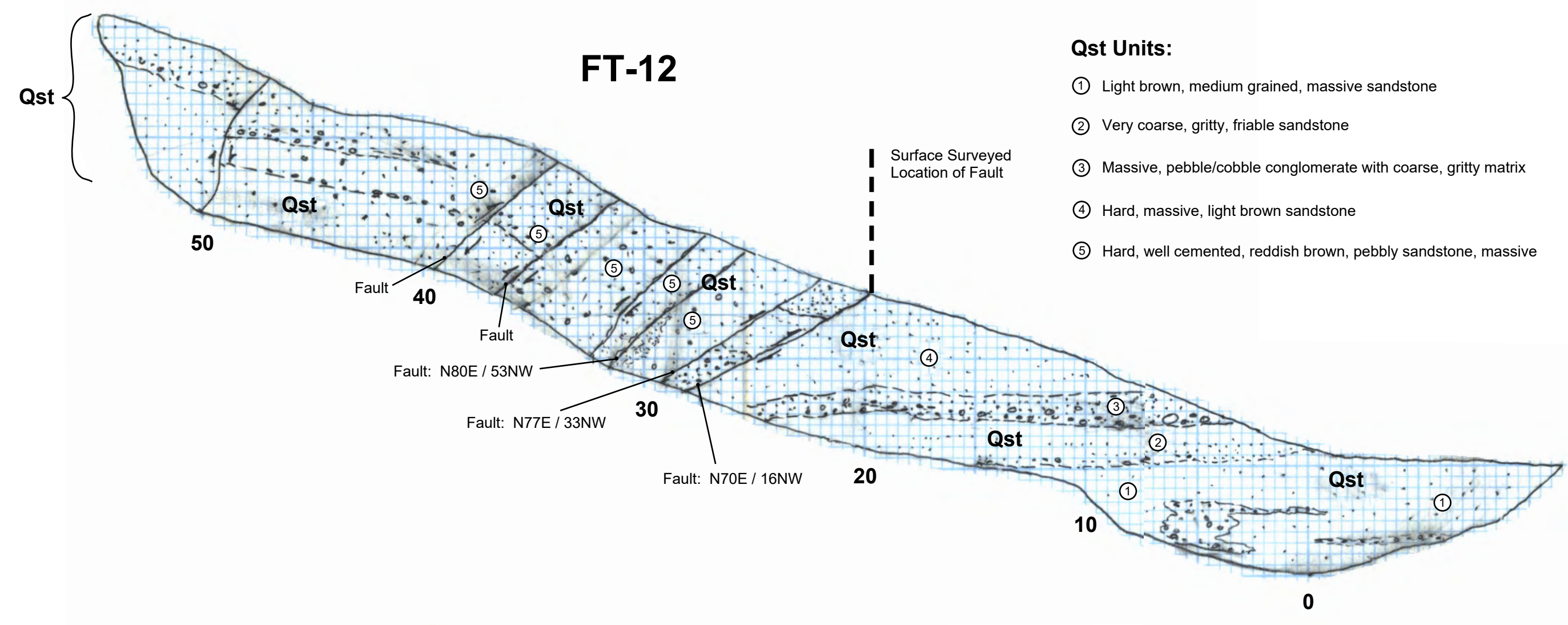
GRAPHIC SCALE  
HORIZONTAL = VERTICAL

**FT-8 thru FT-**

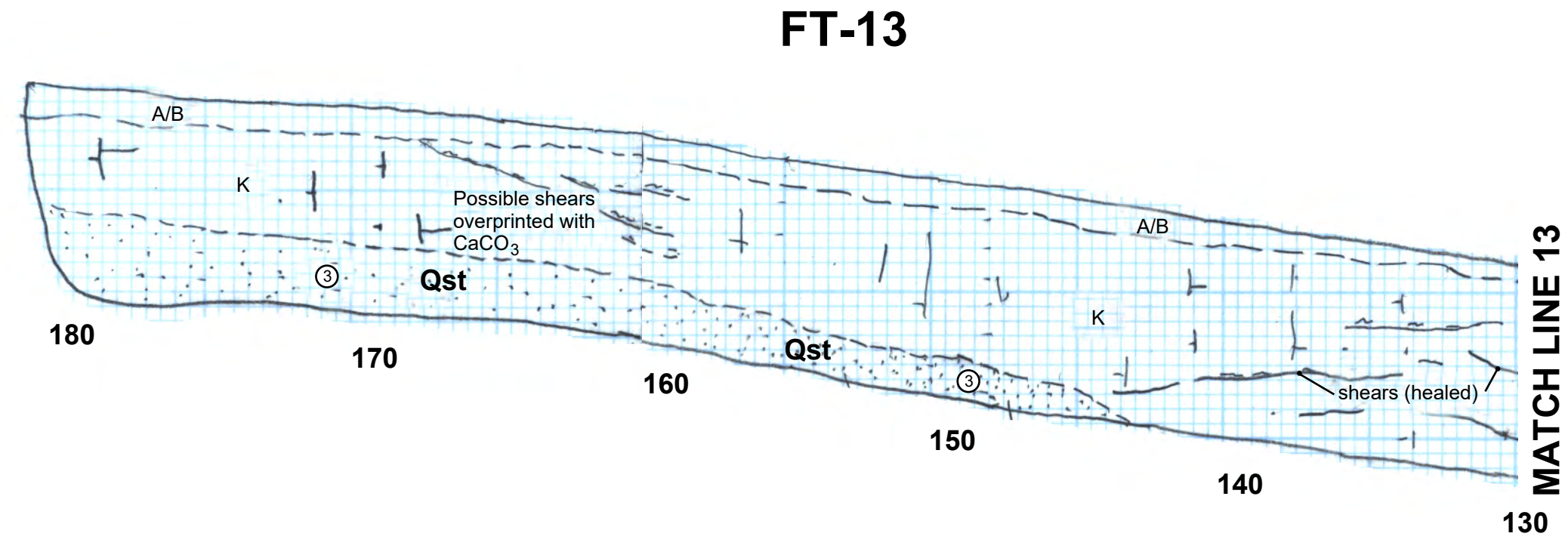
**PETRA GEOTECHNICAL, INC.**  
12225 WORLD TRADE DRIVE, SUITE P  
SAN DIEGO, CALIFORNIA 92128  
PHONE: (619) 485-8030

**FAULT TRENCH EXPLORATION**  
Fiesta Development  
Calimesa, CA

DATE: 10/2004 J.N. 238-04  
DWG BY: DBS SCALE: 1" = 5' **PLATE 5**



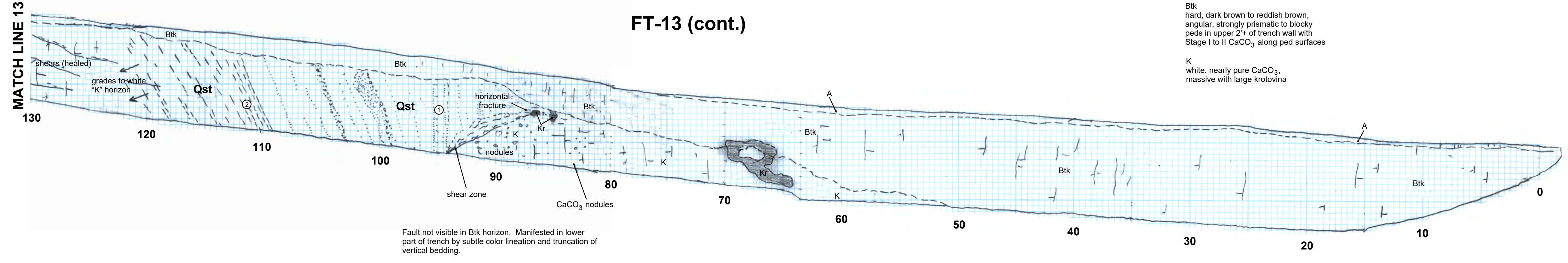
- Qst Units:**
- ① Light brown, medium grained, massive sandstone
  - ② Very coarse, gritty, friable sandstone
  - ③ Massive, pebble/cobble conglomerate with coarse, gritty matrix
  - ④ Hard, massive, light brown sandstone
  - ⑤ Hard, well cemented, reddish brown, pebbly sandstone, massive



- ① Vertical bedding in coarse, gritty, red brown sandstone and pebble conglomerate
- ② Hard, gray brown siltstone with Stage I and II CaCO<sub>3</sub>
- ③ Moderately well cemented, hard, light brown to mottled with orange brown, fine silty sand, in part gritty, massive

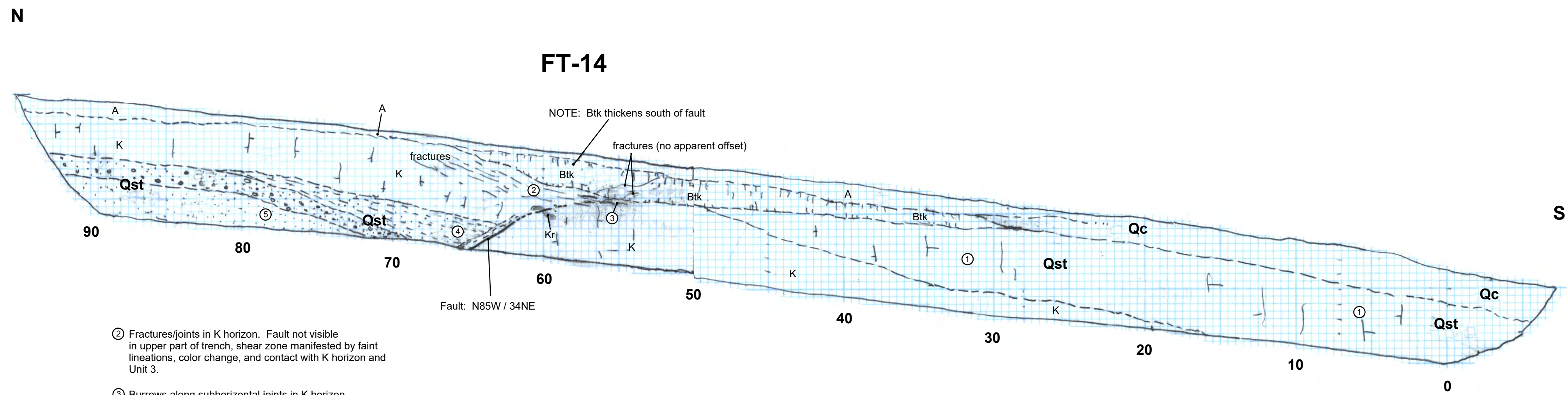
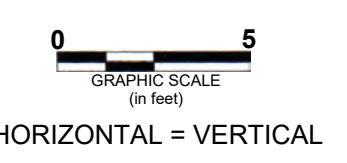
**Btk**  
hard, dark brown to reddish brown, angular, strongly prismatic to blocky peds in upper 2' of trench wall with Stage I to II CaCO<sub>3</sub> along ped surfaces

**K**  
white, nearly pure CaCO<sub>3</sub>, massive with large krotovina



**EXPLANATION**

- HOLOCENE VALLEY ALLUVIUM**
- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
  - Qal<sub>S2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
  - QC** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
  - Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.
- LATE PLEISTOCENE PEDOGENIC SOILS**
- A** A horizon; loose, dry, gray brown silty organic sand
  - Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
  - Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
  - Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
  - K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
  - CBk** This horizon is transitional between slightly weathered parent material and more weathered Btk horizons. In FT-6 the CBk horizon grades laterally to a white K horizon.
  - CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
  - Kr** Krotovina (filled animal burrows).
- PLEISTOCENE BEDROCK**
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.



- ② Fractures/joints in K horizon. Fault not visible in upper part of trench, shear zone manifested by faint lineations, color change, and contact with K horizon and Unit 3.
- ③ Burrows along subhorizontal joints in K horizon
- ④ Hard, well cemented, light brown, massive, very fine sandstone, locally Stages I and II CaCO<sub>3</sub>
- ⑤ Well cemented, massive, light brown, fine to medium grained, silty sandstone
- ① Paleosol, reddish brown, hard, gritty, pebbly, massive, clay present, blocky to prismatic structure, Stage I and II CaCO<sub>3</sub>

**FT-12 thru FT-**

**PETRA GEOTECHNICAL, INC.**  
12255 WORLD TRADE DRIVE, SUITE 100  
SAN DIEGO, CALIFORNIA 92128  
PHONE: (619) 485-5200

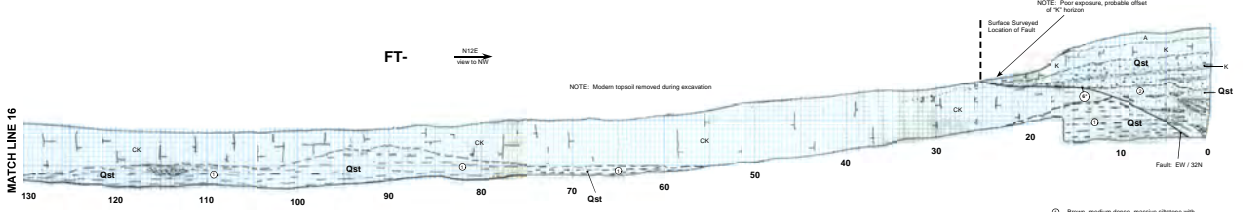
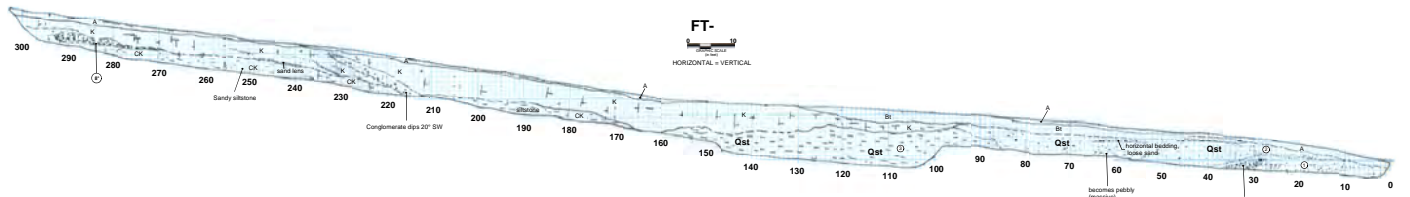
SAN DIEGO MURRIETTA LOS ANGELES COSTA MESA

**FAULT TRENCH EXPLORATION**

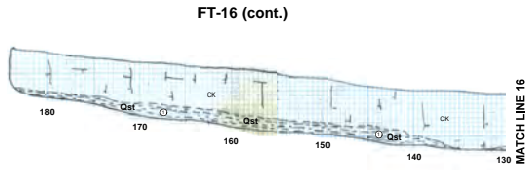
Fiesta Development  
Calimesa, CA

DATE	10/2004	J.N.	238-04
DWG BY:	DBS	SCALE:	1" = 5'

**PLATE 6**



- EXPLANATION**
- HOLOCENE VALLEY ALLUVIUM**
- Qal<sub>1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 8a consisting of undifferentiated down to lightly cemented matrix, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sandstone. Basal silty channel deposits of FT-6 are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some terrace soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the sites at the subject site and dated regional soils developed under similar conditions.
  - Qal<sub>2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash.
  - Qc** Calicheum; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
  - Qcw** Cultural wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from leak seep overtop by 1" thick black organic clay.
- LATE PLEISTOCENE PEDOGENIC SOILS**
- A** A horizon, loose, dry, gray brown silty organic.
  - Bt** Argillic horizon, hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
  - Bk** Argillic horizon with later accumulation of Stage I and II carbonates. Present as thin filaments, small facets, or thin fringes on ped surfaces.
  - Bk** Accumulation of Stage I and II carbonates, generally below well developed argillic horizon, parent material locally recognizable.
  - K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonates creating an essentially white outcrop.
  - CBk** This horizon is transitional between slightly weathered parent material and more weathered Bk horizons. In FT-4 the CBk horizon grades laterally to a white K horizon.
  - CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
  - K0** Kostrovina (flea animal burrows).
- PLEISTOCENE BEDROCK**
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented matrix silt, sand, gravel, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, calcareous sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and marbled by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.



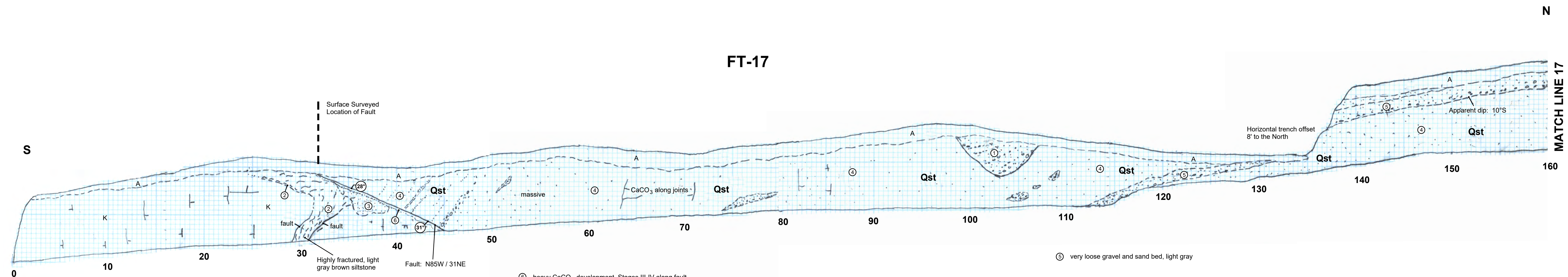
**FT-15 thru FT-**

**PETRA GEOTECHNICAL INC.**  
 10000 Judd Rd., Suite 200  
 Irvine, CA 92618  
 (949) 450-9000

**FAULT TRENCH EXPLORATION**

Pleisto Development  
 Calistoga, CA

DATE: 10/20/04	J.N.	2/8/04	<b>PLATE 7</b>
DWG BY: DBS	SCALE: 100' HORIZ.		



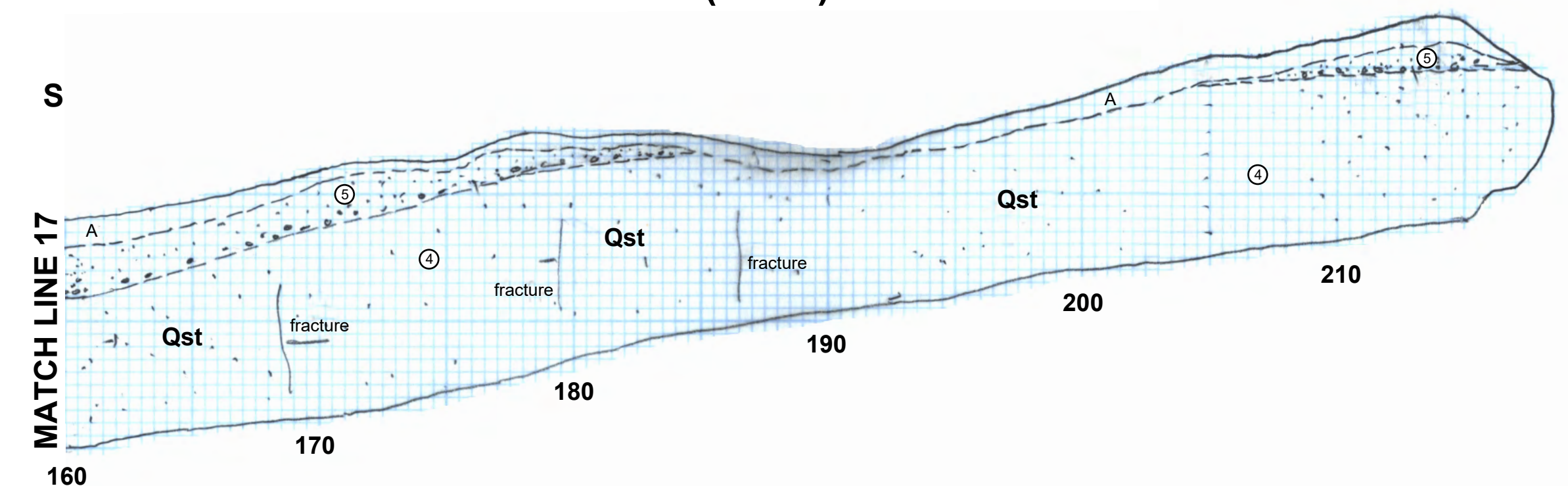
- Surface Surveyed Location of Fault
- Highly fractured, light gray brown siltstone
- Fault: N85W / 31NE
- ① conglomerate filled Holocene channel
  - ② zone of intense fracturing
  - ③ light reddish brown, massive, clayey sandstone with few pebbles
  - ④ dense, dry, thickly bedded fine sandstone with few cobble conglomerate beds, massive, fine grained, light reddish brown sandstone with CaCO<sub>3</sub> along fractures

⑤ heavy CaCO<sub>3</sub> development, Stages III-IV along fault, no visible gouge in overlying sand, fault plane locally well developed in sandstone, very faint slicken sides parallel to dip of plane (possible replacement of gouge by CaCO<sub>3</sub> below fault surface)

⑥ very loose gravel and sand bed, light gray

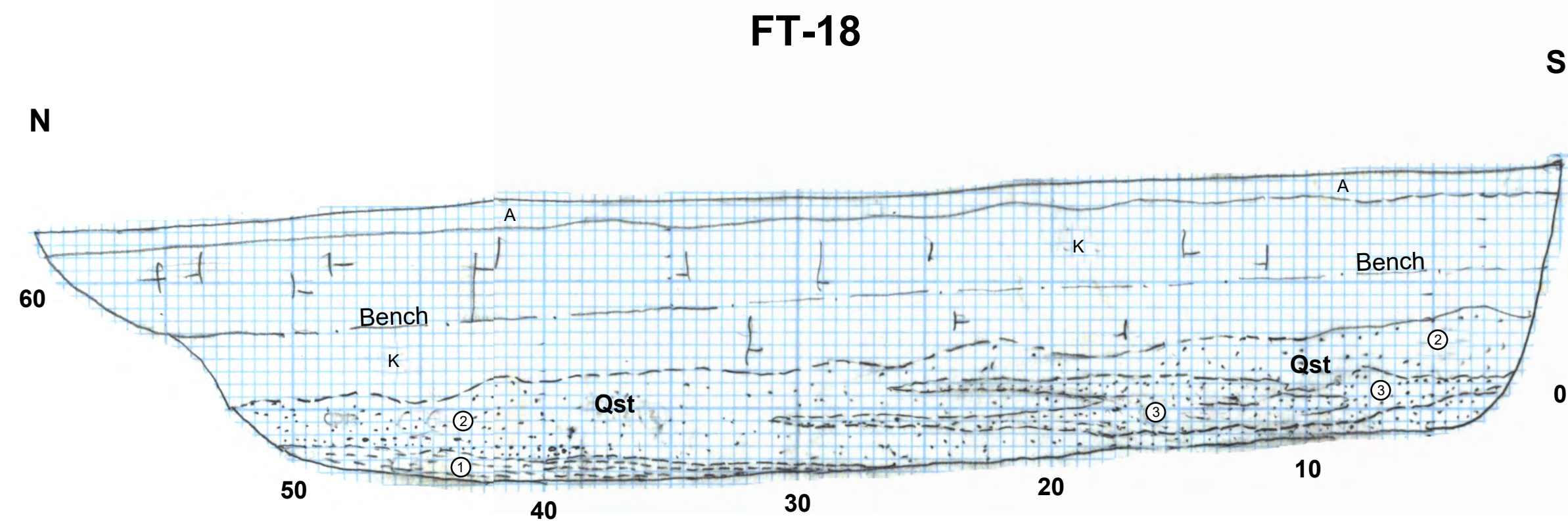
FT-17

FT-17 (cont.)

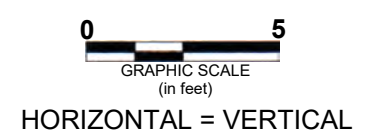


EXPLANATION

- HOLOCENE VALLEY ALLUVIUM
- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
  - Qal<sub>S2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
  - Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
  - Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.
- LATE PLEISTOCENE PEDOGENIC SOILS
- A** A horizon; loose, dry, gray brown silty organic sand
  - Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
  - Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
  - Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
  - K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
  - CBk** This horizon is transitional between slightly weathered parent material and more weathered Btk horizons. In FT-6 the CBk horizon grades laterally to a white K horizon.
  - CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
  - Kr** Krotovina (filled animal burrows).
- PLEISTOCENE BEDROCK
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thin bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.



- ① light brown, lightly cemented, massive, very fine grained sandy siltstone
  - ② interbedded, very coarse grained, orange brown sand and pebble conglomerate and moderately cemented, light gray brown fine sand
  - ③ loosely cemented, very coarse, gritty sand, orange brown to reddish brown
- A horizon  
very loose (tilled?), light gray brown silty to clayey sand with 1/8" rootlets, numerous krotovina
- K  
loose to moderately cemented, white to light gray, silty, developed in dark brown clay, highly fractured with 1/2" thick veins and nodules of CaCO<sub>3</sub>

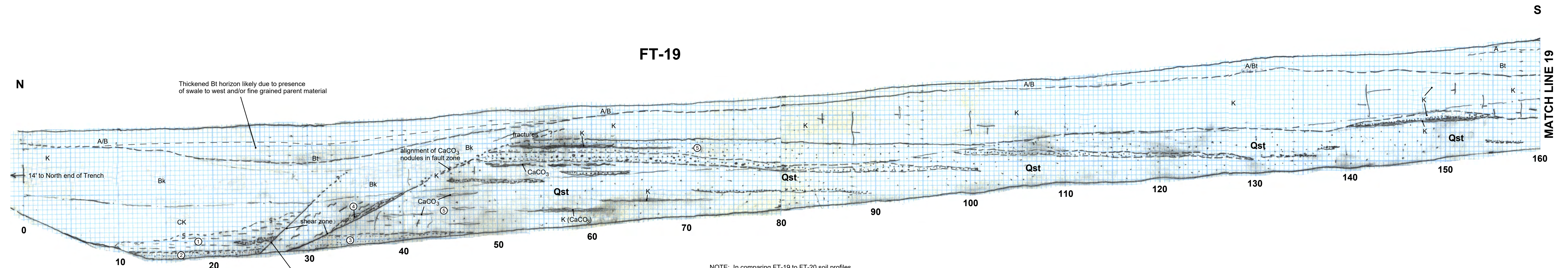


**FT-17 thru FT-**

**PETRA GEOTECHNICAL, INC.**  
1225 WORLD TRADE DRIVE, SUITE P  
SAN DIEGO, CALIFORNIA 92128  
PHONE: (619) 485-5030

**FAULT TRENCH EXPLORATION**  
Fiesta Development  
Calimesa, CA

DATE: 10/2004 J.N. 238-04  
DWG BY: DBS SCALE: 1" = 5' **PLATE 8**



- ① light brown, massive siltstone
- ② light gray, coarse grained, cohesionless gritty sand
- ③ loosely cemented, gray brown, coarse sand and silty sandstone
- ④ orange brown, coarse grained, massive sandstone along fault with CaCO<sub>3</sub> veins parallel to fault
- ⑤ interbedded gray brown sandstone and orange brown siltstone with Stage I and II CaCO<sub>3</sub>, numerous CaCO<sub>3</sub> veins and nodules

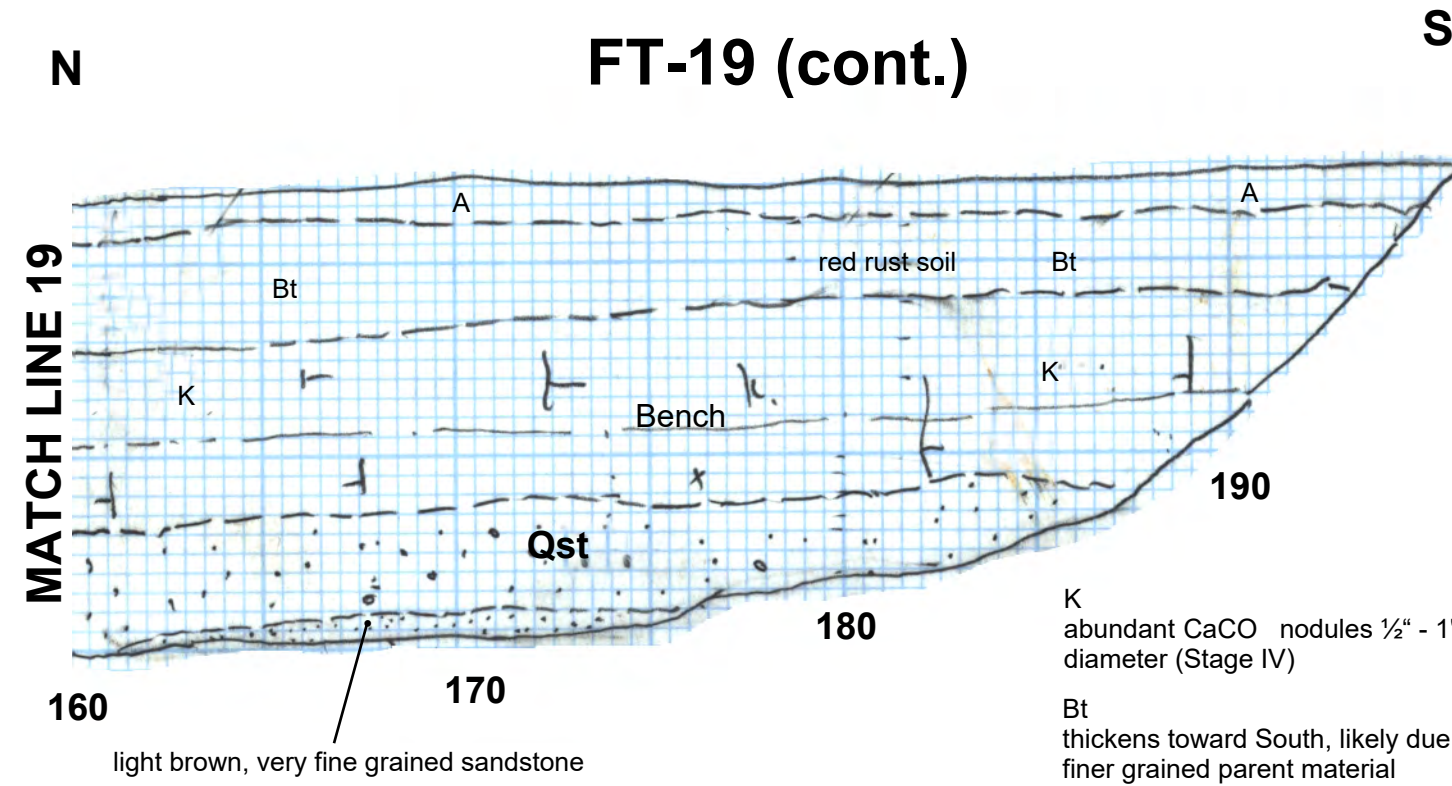
Fault: N80W / 40NE  
manifested in lower part of trench by sharp lithologic change, no gouge, very subtle zone of shearing, numerous CaCO<sub>3</sub> fragments <1/8" in fault zone, no discrete fault plane apparent

Bt  
very well developed angular, blocky peds

Bk - K  
gradual at base with siltstone at N end of trench, white with 1/4" - 1/2" nodules and thick CaCO<sub>3</sub> veins to solid CaCO<sub>3</sub>, this trench does expose a true "K" horizon in places where no parent material is visible and unit is nearly all CaCO<sub>3</sub> (Stage IV)

NOTE: In comparing FT-19 to FT-20 soil profiles, FT-19 in the footwall rocks has a more developed Bk - K soil profile and thinner Bt horizon likely due to coarse grained soils near the surface.

In FT-19, the soil profile in the hanging wall rocks is similar to FT-20 due to finer grained soils exposed near the surface (parent material).



K  
abundant CaCO<sub>3</sub> nodules 1/2" - 1" diameter (Stage IV)

Bt  
thickens toward South, likely due to finer grained parent material

**EXPLANATION**

**HOLOCENE VALLEY ALLUVIUM**

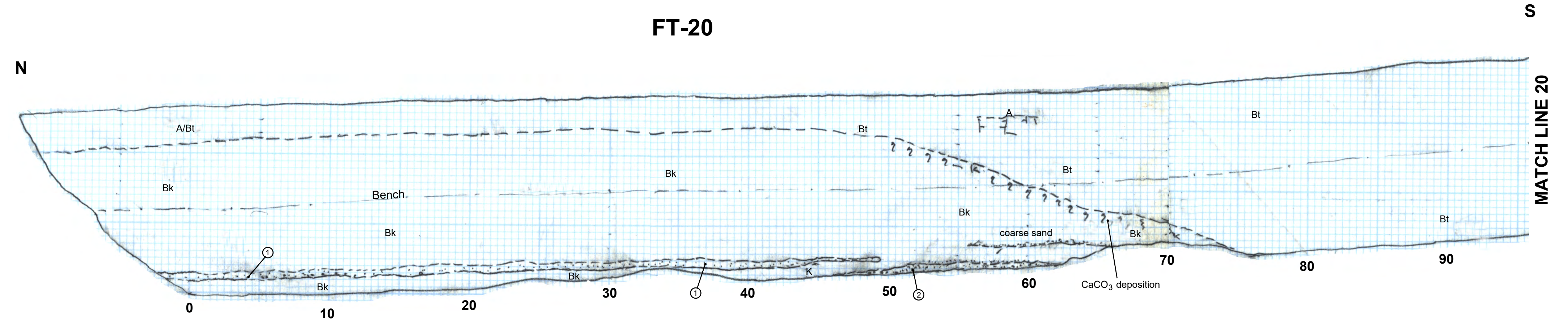
- Qal<sub>s1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-6 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
- Qal<sub>s2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
- Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
- Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.

**LATE PLEISTOCENE PEDOGENIC SOILS**

- A** A horizon; loose, dry, gray brown silty organic sand
- Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
- Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
- Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
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- Kr** Krotovina (filled animal burrows).

**PLEISTOCENE BEDROCK**

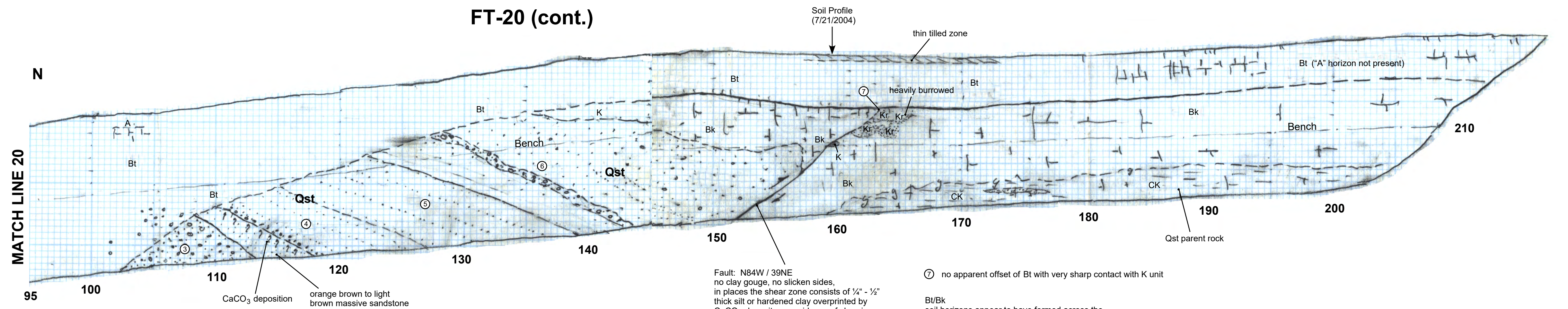
- Qst** San Timoteo Formation: Early to Mid-Pleistocene sediments consisting of poorly to moderately consolidated or cemented fluvial silts, sands, gravels, and cobble conglomerates with interbedded paleosols. Sandstones vary in lithology from well-sorted, coarse grained, cohesionless sands to moderately cemented, poorly sorted silty, clayey fine sands. Sandstones are generally thinly bedded and manifested by color and textural changes. Conglomerates are generally thin, on the order of several feet thick and coarsely bedded.



- ① loose, very coarse, gritty sand bed within "K" horizon with heavy CaCO<sub>3</sub> development
- ② lightly cemented, light brown, massive silty sand

A/Bt  
undifferentiated "A" and Bt horizons. Dark brown with very well developed small, blocky (1" - 2") peds, with well developed clay films, strong reddish hue near fault (5YR)

**FT-20 (cont.)**

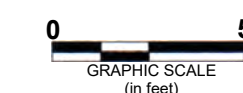


- ③ pebble conglomerate with light brown to gray brown medium grained silty sand matrix
- ④ fining upward bed of pebble conglomerate (basal) and sandstone
- ⑤ moderately well cemented reddish brown massive silty fine sand
- ⑥ massive, moderately cemented, light brown to reddish brown silty sandstone with Stage I CaCO<sub>3</sub> development, few pebbles present

Fault: N84W / 39NE  
no clay gouge, no slicken sides, in places the shear zone consists of 1/4" - 1/2" thick silt or hardened clay overprinted by CaCO<sub>3</sub> deposits, no evidence of shearing, shear zone appears overprinted with CaCO<sub>3</sub> (healed)

⊙ no apparent offset of Bt with very sharp contact with K unit

Bt/Bk  
soil horizons appear to have formed across the exposed fault, base of Bt is relatively sharp (well defined) and is undisturbed by faulting



**FT-19 thru FT-**

**PETRA GEOTECHNICAL, INC.**  
1225 WORLD TRADE DRIVE, SUITE P  
SAN DIEGO, CALIFORNIA 92128  
PHONE: (619) 485-5030

**FAULT TRENCH EXPLORATION**

Fiesta Development  
Calimesa, CA

DATE: 10/2004 J.N. 238-04  
DWG BY: DBS SCALE: 1" = 5' **PLATE 9**

***APPENDIX B***

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***Soil Analysis Data  
By Mitch Borneyasz***



PEDON											
ID	T-4 SP-1		Sta. 0+09'	Landform	Axis of small drainage off side of prominent geomorphic surface						
Class				Veg.	Sparse brush and grasses						
P.M.	Qal&Qcol shed from Qsti		Age of development	Source	MSB						
	DEPTH (ft)	DEPTH (cm)	COLOR (dry, moist)	TEXTURE	STRUCTURE	CONSIS (dry or moist; wet)	CLAY FILMS	BOUNDARY	H.I.	SDI	NOTES
A	0-2.9		10YR4/4d; 3.5/3m	SL	m-2msbk	so; so, po	n.o.	g, w			Qcol
	2.9	88.4	0.15	0.40	0.25	0.20	0.00		0.14	12.63	
BC	2.9-5.0		10YR5/6d; 4/4m	SL-SCL	m-1-2mabk	so; so, po-ps	n.o.	c, w			Qcol
	2.1	64.0	0.30	0.45	0.29	0.28	0.00		0.19	12.12	24.74
2Ab	5.0-6.9		10YR4/6d; 4/4m	SCL	m-2msbk	sh; so, ps	n.o.	a-c, w			Coarse Qal
	1.9	57.9	0.30	0.50	0.25	0.57	0.00		0.23	13.37	
3Bwb	6.9-10.0		10YR5/6d; 4/4m	SL	m-2m-fsbk	so; so, po	n.o.	c, w			Fineer Qcol/Qal
	3.1	94.5	0.30	0.40	0.25	0.20	0.00		0.16	15.52	28.80
4ABb2	10.0-11.7		10YR5/6d; 4/4m	SL	m-2msbk-abk	sh; so, po	n.o.	c, w-l			Fine Qcol
	1.7	51.8	0.30	0.40	0.29	0.40	0.00		0.20	10.30	
5BCb2	11.7-13.7		7.5YR4/6d; 4/4m	SCL	m-1-2fsbk&s.g.	sh-lo; so, po	*	a, w			Coarse Qal & Reworked Paleosol
	2	61.0	0.35	0.50	0.17	0.20	-		0.17	10.60	* stgr & 1-2nd clay from eroded paleosol P.M.
6Cr	13.7+		10YR5/6d; 5/4m	S-SCL	bedded 2-3fabk	h, so, po	stgr, 1-2nbr, 1incl	n.o.			Upper member of San Timoteo Fm.
	-		n/a	n/a	n/a	n/a	n/a				
total		417.6							SDI Total	74.54	
									SDI @ 250	44.69	

PEDON											
ID	T-3a SP-2		Sta. 0+20'	Landform	Side of small drainage off side of prominent geomorphic surface						
Class				Veg.	Sparse brush and grasses						
P.M.	Qsti Bedrock		Age of development	Source	MSB						
	DEPTH (ft)	DEPTH (cm)	COLOR (dry, moist)	TEXTURE	STRUCTURE	CONSIS (dry or moist; wet)	CLAY FILMS	BOUNDARY	H.I.	SDI	NOTES
A	0-0.3		10YR5/4d; 4/3m	SCL	3m-fsbk&gr	sh-h; ss, ps	n.o.	c, s-w			
	0.3	9.1	0.15	0.60	0.67	0.83	0.00		0.32	2.94	Eroding surface/ minimum soil age
Bt	0.3-1.0		10YR-7.5YR4/5d; 4/4m	SL-SCL	3fabk-pr	h-vh; so-ss, ps	2vibr, stipf & 1-2npo	c, s-w			
	0.7	21.3	0.28	0.50	0.92	0.95	0.50		0.45	9.58	
BC	1.0-2.5		10YR4/5d; 4/4m	SL-SCL	3fabk	h-vh; so-ss, ps	stgr	g, s			
	1.5	45.7	0.25	0.50	0.83	0.95	0.17		0.39	17.63	
Cox	2.5-6.5		10YR4/5d; 4/4m	fS	bedded-3fabk	h; so, po	n.o.	g, s			
	4	121.9	0.25	0.00	0.42	0.60	0.00		0.18	22.06	
Cr	6.5+		10YR7/8-6/6d	fS	bedded 2-3fabk	h; so, po	n.o.	n.o.			
	-		n/a	n/a	n/a	n/a	n/a	n/a			
total		198.1							SDI Total	52.21	
									SDI @ 250	51.26	

PEDON											
ID	T-20 SP-3	Sta.1+60"	Landform	Stable elevated geomorphic surface							
Class			Veg.	Sparse brush and grasses							
P.M.	Qsti Bedrock		Source	MSB							
			Age of development								
HORIZON	DEPTH (ft)	DEPTH (cm)	COLOR (dry,moist)	TEXTURE	STRUCTURE	CONSIS (dry or moist; wet)	CLAY FILMS	BOUNDARY	H.I.	SDI	NOTES
Bt1	0-0.4	0-12	10YR4/4d, 7.5-10YR3/4m	SC-CL	2m-cabk	vh; s, p	3kbr, 2-3mkpf, 2mkpo	c, s			
	0.4	12	0.23	0.80	0.67	1.47	0.80		0.57	6.69	
Bt2	0.4-2.3	12-70	7.5YR3.5/6-3/4d, 3/4m	C	3cabk-pr	vh-eh; vs, vp	3-4kbr, 3mkpf, 2kpo	c, s			
	1.9	58	0.35	1.00	0.92	1.90	0.87		0.72	41.64	
Bt3	2.3-3.2	70-128	7.5YR4/4d, 3/4m	SC-CL	3fabk-pr	vh; vs, vp	3kbr, 3mkpf, 1kpo	c, s			
	0.9	27	0.30	0.80	0.92	1.80	0.80		0.86	18.09	
Btk	3.2-4.1	128-155	7.5YR4/8d, 4/4m	SC-CL	2mabk-sbk	h; s, p	2-3mkbr, 2npf	a-c, w			Stage I Carbonate
	0.9	27	0.40	0.80	0.58	1.27	0.60		0.52	14.30	
Bk1	4.1-6.0	155-183	10YR7/3.5d, 4/8m	fSL	m-2f-msbk	h; ss, ps	n.o.	c, w			Stage III+ Carbonate
	1.9	58	0.28	0.40	0.50	0.93	0.00		0.30	17.44	
Bk2	6.0-7.8	183-241	10YR7/3.5d, 4/6m	fSL	m-2fabk	sh; so, po	n.o.	c, w			Stage II Carbonate
	1.8	55	0.28	0.40	0.50	0.40	0.00		0.23	12.34	
Ck	7.8-9.7	241-298	10YR6/4d, 4/5m	fSL	2fabk-sbk	sh; so, po	n.o.	g, s-w			Stage I Carbonate
	1.9	58	0.25	0.40	0.58	0.40	0.00		0.23	13.51	
C	9.7-12.6+	296-384	10YR8/4d, 4/5m	fS-LS	m-2fabk-sbk	sh; so, po	n.o.				
	2.9	88	0.25	0.10	0.58	0.00	0.00		0.13	11.73	
									SDI @ 300cm	124.23	

KEY

Color: Standard Munsell Soil Color Chart Notation

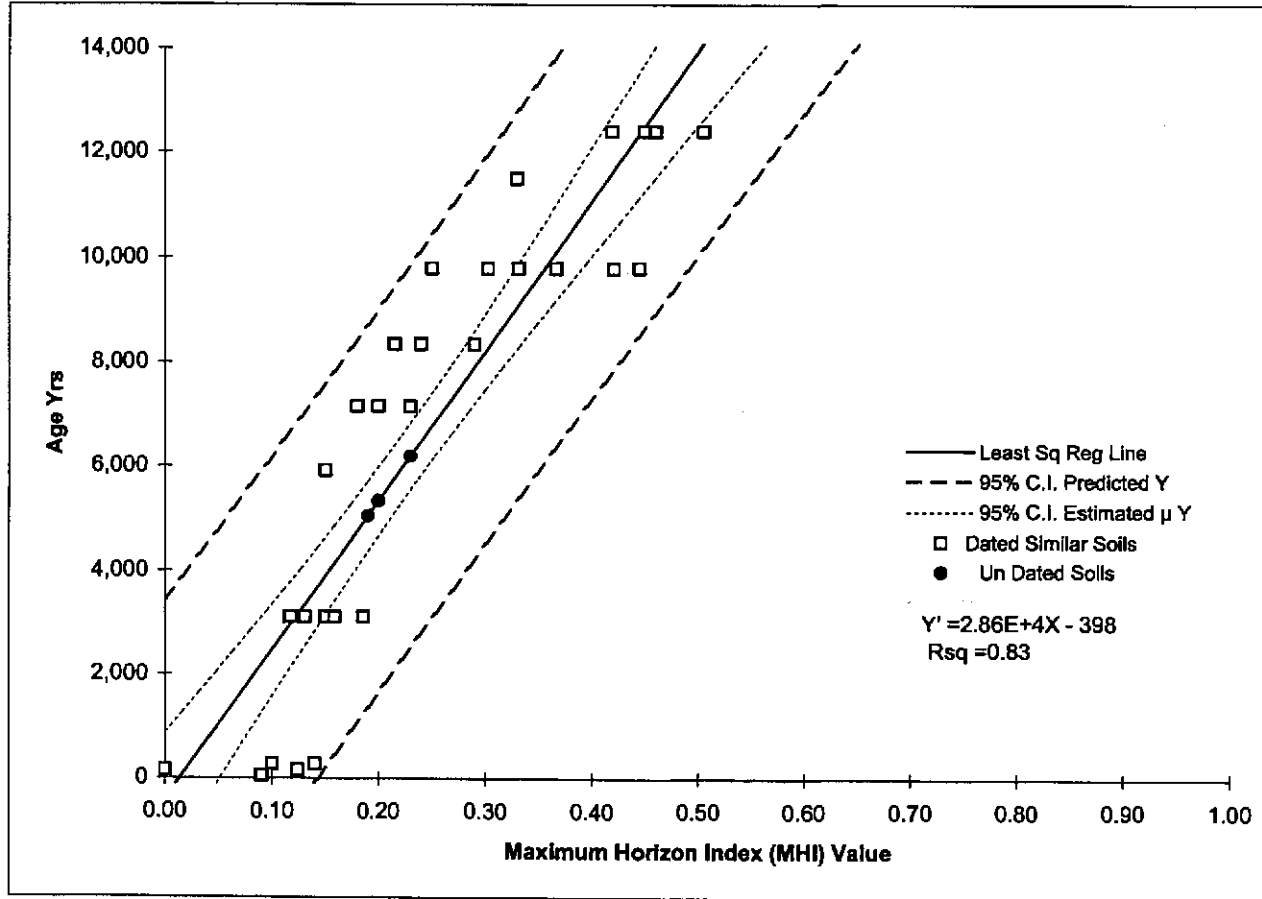
Texture: g-Gravel, S-sand, LS-Loamy Sand, SL-Sandy Loam, SCL-Sandy Clay Loam, SC-Sandy Clay, C-Clay

Structure: 1-Weak, 2-Moderate, 3-Strong; f-Fine, m-Medium, c-Coarse; s.g.-Single grain, m-massive, sbk-Subangular Blocky, abk-Angular Blocky, pr-Prismatic

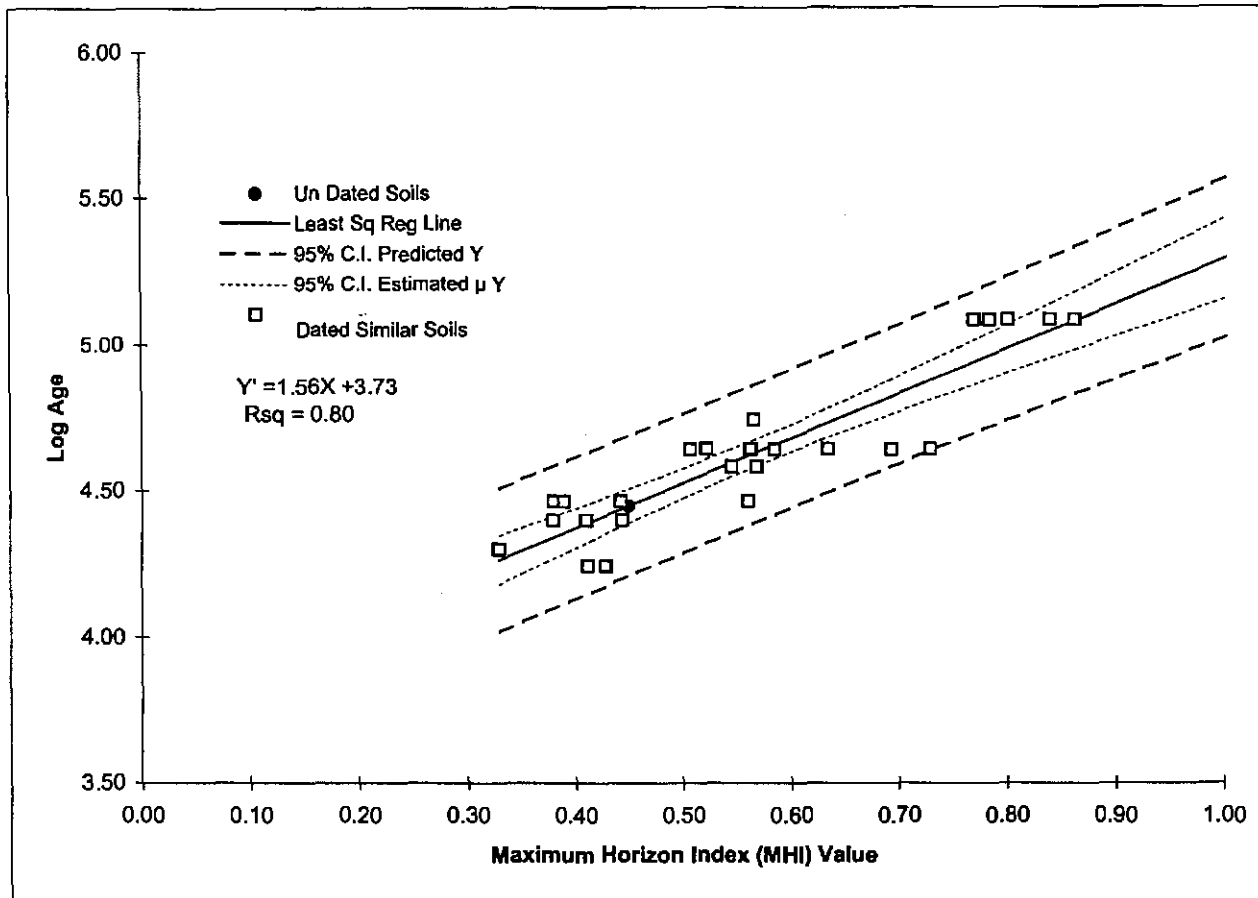
Consistence: (dry) to-Loose, so-Soft, sh-Slightly hard, h-Hard, vh-Very hard, eh-Extremely hard; (wet) so-Nonsticky, se-Slight sticky, e-Sticky, ve-Very sticky, po-Nonplastic,

Clay Films: n-Thin, mik-Moderately thick, k-Thick; v1-Very few, 1-Few, 2-Common, 3-Many, 4-Continuous; po-in pores, br-Bridging grains, pf-On ped faces, cl-Coating clasts

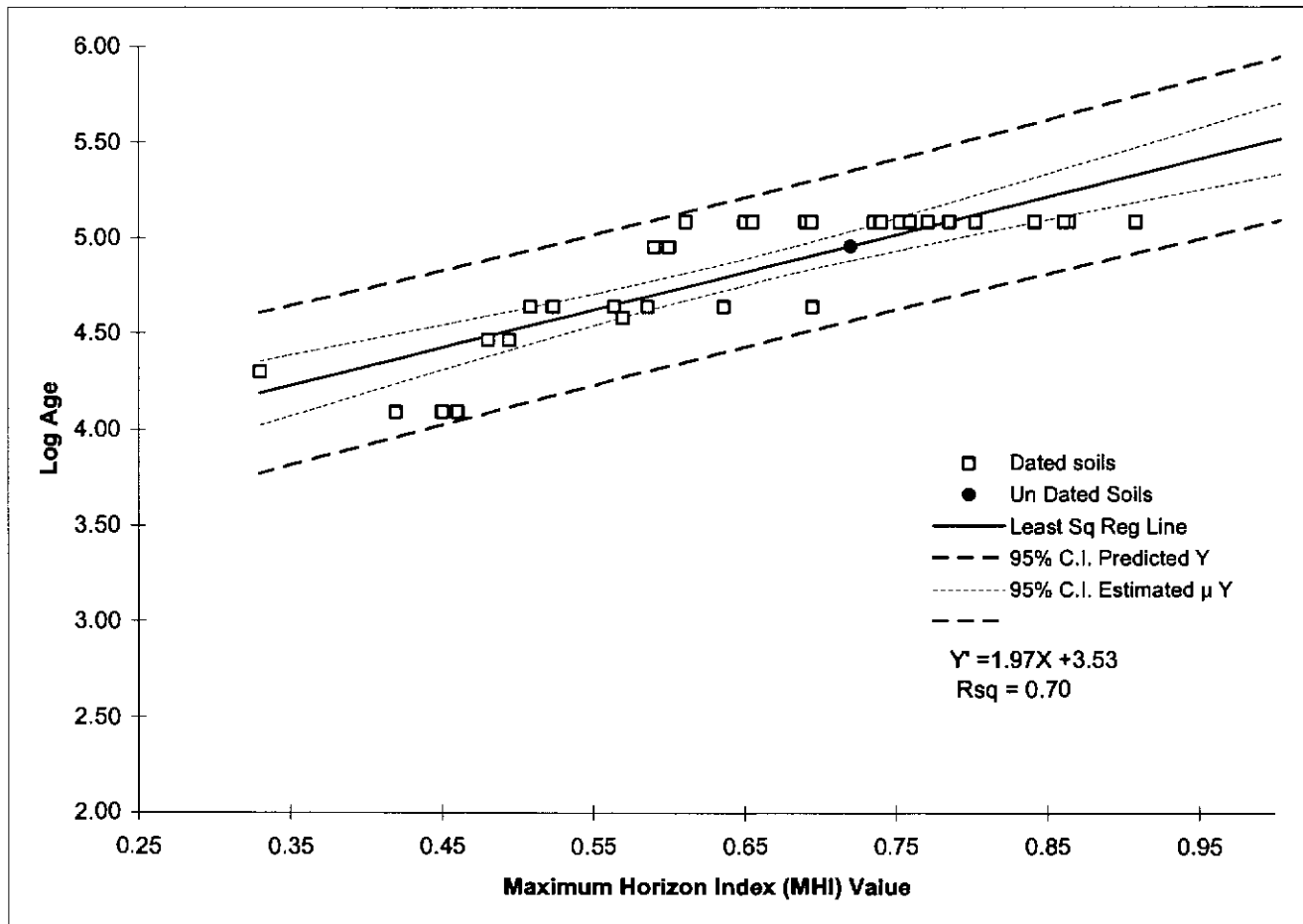
Horizon Boundaries: a-Abrupt, c-Clear, g-Gradual, d-Diffuse, s-Smooth, w-Wavy, Irregular



Profile	MHI	Age	Error in $\mu$ of Y		95% Predicted Age C.I.	
			Max	Min	Max	Min
SP-1 upper	0.19	5,044	5,711	4,377	8,724	1,365
SP-1 mid	0.23	6,190	6,830	5,550	9,865	2,516
SP-1 lower	0.20	5,331	5,986	4,675	9,008	1,653



Profile	MHI	Log Age	Max Error in $\mu$ of Y	Min Error in $\mu$ of Y	Max Error in Y pop	Min Error in Y pop	Age (yrs)	95% Predicted Age C.I.	
								Max	Min
SP-2	0.45	4.45	4.50	4.39	4.68	4.21	27,935	48,367	16,135



Profile	MHI	Log Age	Max Error in $\mu$ of Y	Min Error in Y pop.	Age (yrs)	95% Predicted Age C.I.	
						Max	Min
T-20 SP-3	0.72	4.96	5.03	4.57	90,597	223,328	36,753

## Methods

The soils exposed were described according to the characteristics and nomenclature set forth by the Soil Survey Staff (1975, 1992) and Birkeland (1984). The profile descriptions (Table I) were used to calculate the degree of development for the soils exposed in each of the deposits. Soil development index values were calculated for these soils based on a modified version of the maximum horizon index (MHI) of Ponti (1985). Age estimates for the deposits are based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.

## References

- Birkeland, P.W., 1984b, *Soils and Geomorphology*: Oxford University Press, New York, 372 p.
- Harden, J.W., 1982, A quantitative index of soil development from field descriptions: Examples from a chronosequence in central California: *Geoderma*, V. 28, 1-28.
- Harrison, J. B. J., McFadden, L. D., and Weldon III, R. J., 1990, Spatial soil variability in the Cajon Pass chronosequence: implications for the use of soils as a geochronological tool: *Geomorphology* 3, p. 399-416.
- Ponti, D. J., 1985, The Quaternary alluvial sequence of the Antelope Valley, California: Geological Society of America, Special Paper 203, p. 79-96.
- Soil Survey Staff, 1975, *Soil Taxonomy*: U.S. Department of Agriculture Handbook 436, U.S. Govt. Printing Office, Washington.
- Soil Survey Staff, 1992, *Keys to Soil Taxonomy*: 5th edition. SMSS technical monogr. 19. Blacksberg, Virginia: Pocahontas Press, Inc., 556 P.

**EXPLANATION**

**HOLOCENE VALLEY ALLUVIUM**

- Qal<sub>S1</sub>** Younger alluvium and slopewash of Fault Trenches 2, 4, 6, and 6a consisting of undifferentiated loose to lightly cemented friable, dark brown to light gray brown, silty fine sand. Typically has a basal conglomerate with silty to well-sorted fine to medium grained sand matrix. Basal alluvial channel deposits of FT-6a are a very loose pebble conglomerate with light gray brown, well-sorted coarse sand matrix. Some immature soil development present as buried soil horizons in FT-4 and FT-5 with estimated soil profile cumulative age of approximately 5,000 years old based on the statistical comparison of soil development between the soils at the subject site and dated regional soils developed under similar conditions.
- Qal<sub>S2</sub>** Older alluvium of Fault Trench 7 (FT-7). Undifferentiated alluvium and slopewash with moderately well-developed soil profile at ground surface. Consists generally of dark brown clayey fine to medium-grained sand and sandy clay.
- Qc** Colluvium; very stiff, dry to damp, dark brown clay and sandy clay with grit and few pebbles.
- Qcw** Colluvial wedge in fault zone of FT-7 consisting of mixture of organic brown silty sand and conglomeratic debris from fault scarp overlain by 1" thick black organic clay.

**LATE PLEISTOCENE PEDOGENIC SOILS**

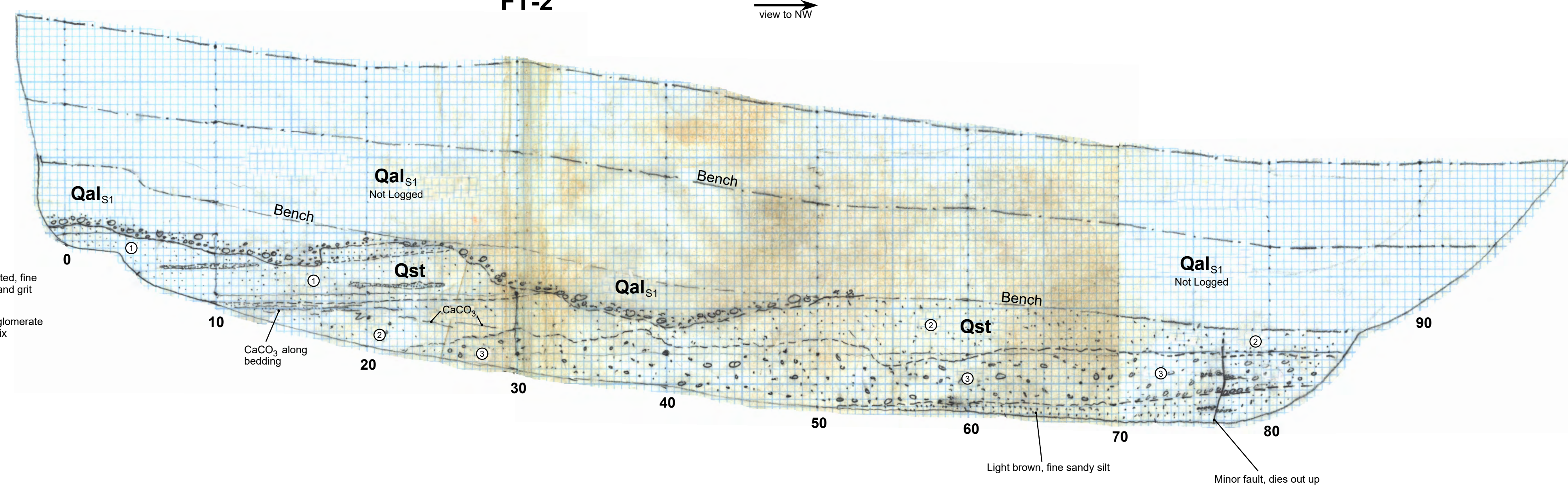
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- Bt** Argillic horizon; hard, dark brown sandy clay and clay with blocky to prismatic peds with moderately to well-developed clay films on ped surfaces. See logs for estimated age determination of soil.
- Btk** Argillic horizon with later accumulation of Stage I and II carbonate. Present as thin filaments, small flecks, or thin linings on ped surfaces.
- Bk** Accumulation of Stage I and II carbonate, generally below well developed argillic horizon, parent material locally recognizable.
- K** The K horizon represents domination of carbonates with Stage III or higher carbonate development. Most grains are coated with carbonate creating an essentially white outcrop.
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- CK** Transitional horizon between relatively unweathered parent material and K horizon. Generally has Stage I CaCO<sub>3</sub> development, parent material prominent and recognizable.
- Kr** Krotovina (filled animal burrows).

**PLEISTOCENE BEDROCK**

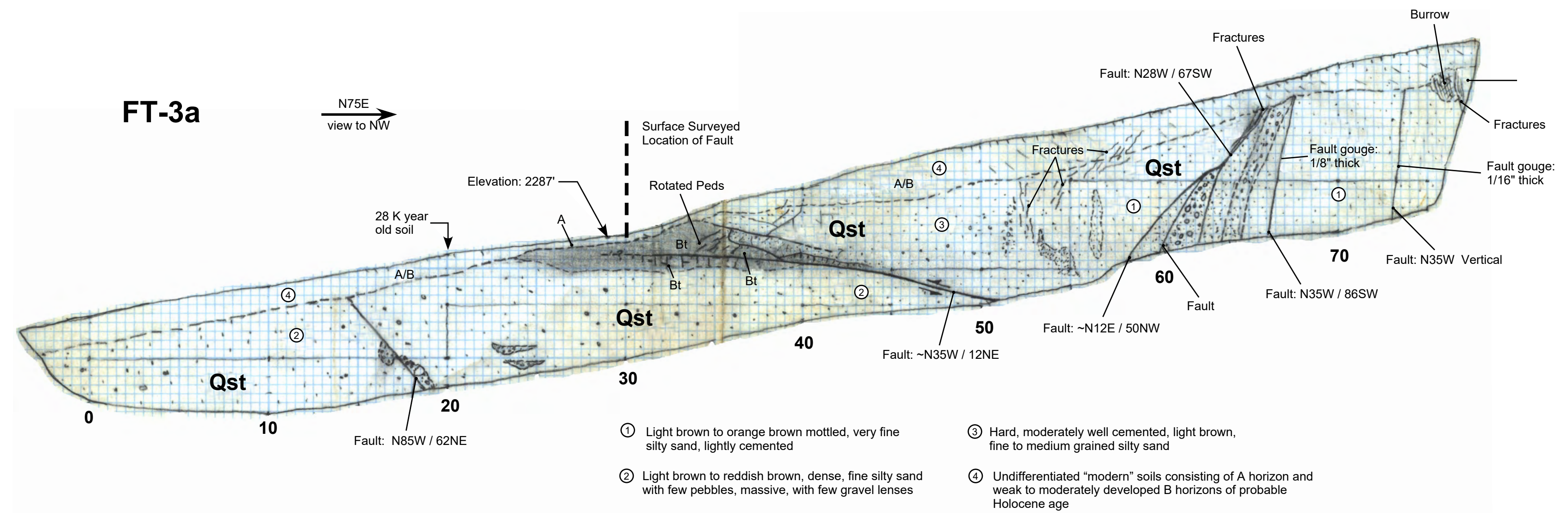
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**FT-2**  
N65E  
view to NW

- ① Slightly cemented, light brown very fine silty sand, massive
- ② Light brown, moderately well-cemented, fine grained silty sand with few pebbles and grit
- ③ Dense, dry, light brown pebble conglomerate with medium grained silty sand matrix

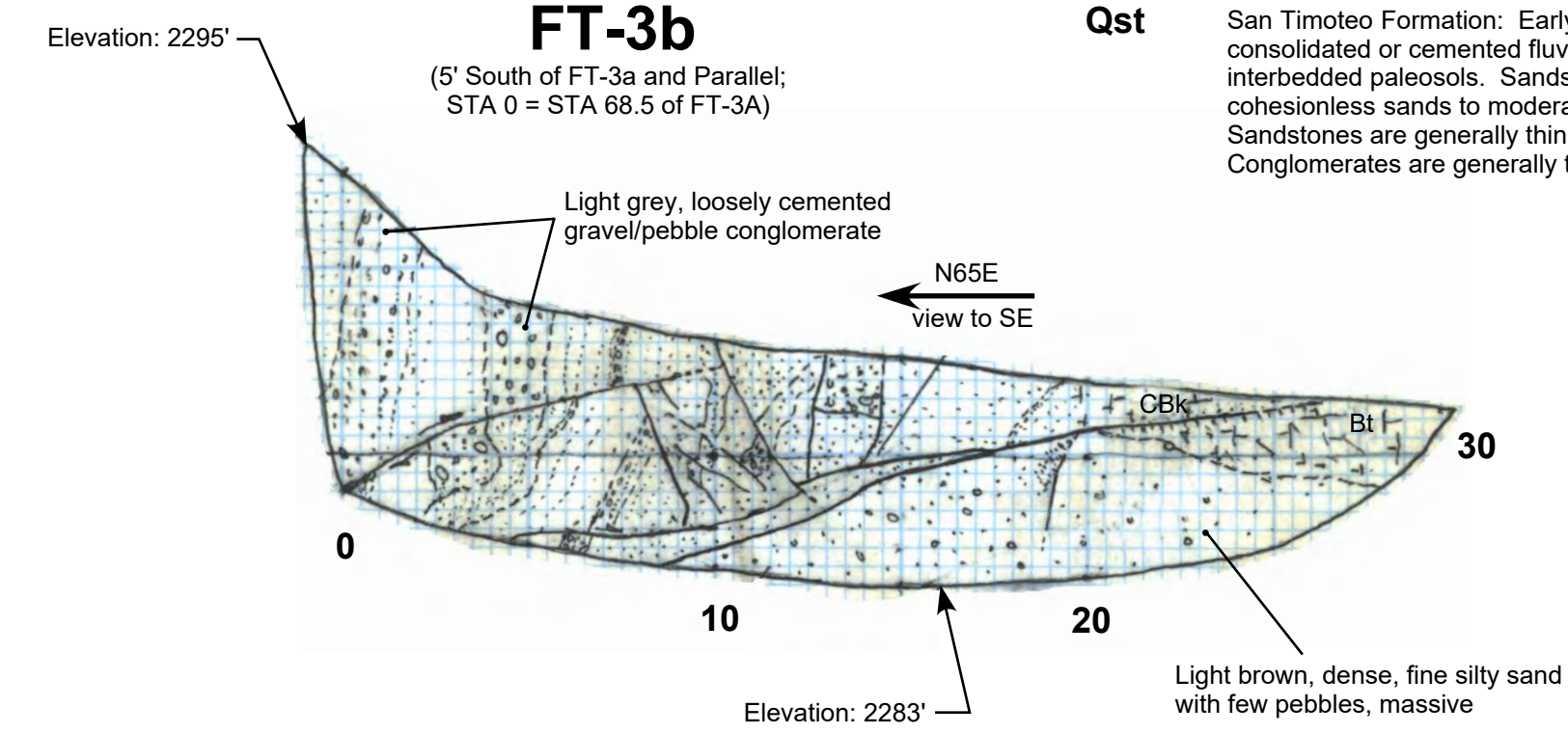


**FT-3a**  
N75E  
view to NW

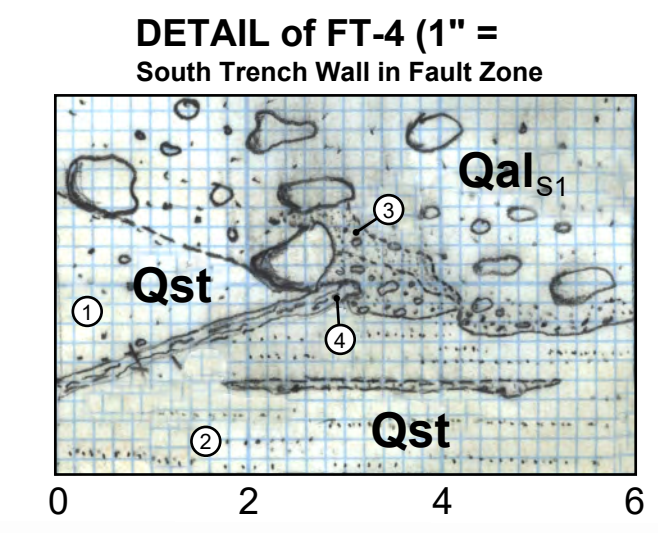


- ① Light brown to orange brown mottled, very fine silty sand, lightly cemented
- ② Light brown to reddish brown, dense, fine silty sand with few pebbles, massive, with few gravel lenses
- ③ Hard, moderately well cemented, light brown, fine to medium grained silty sand
- ④ Undifferentiated "modern" soils consisting of A horizon and weak to moderately developed B horizons of probable Holocene age

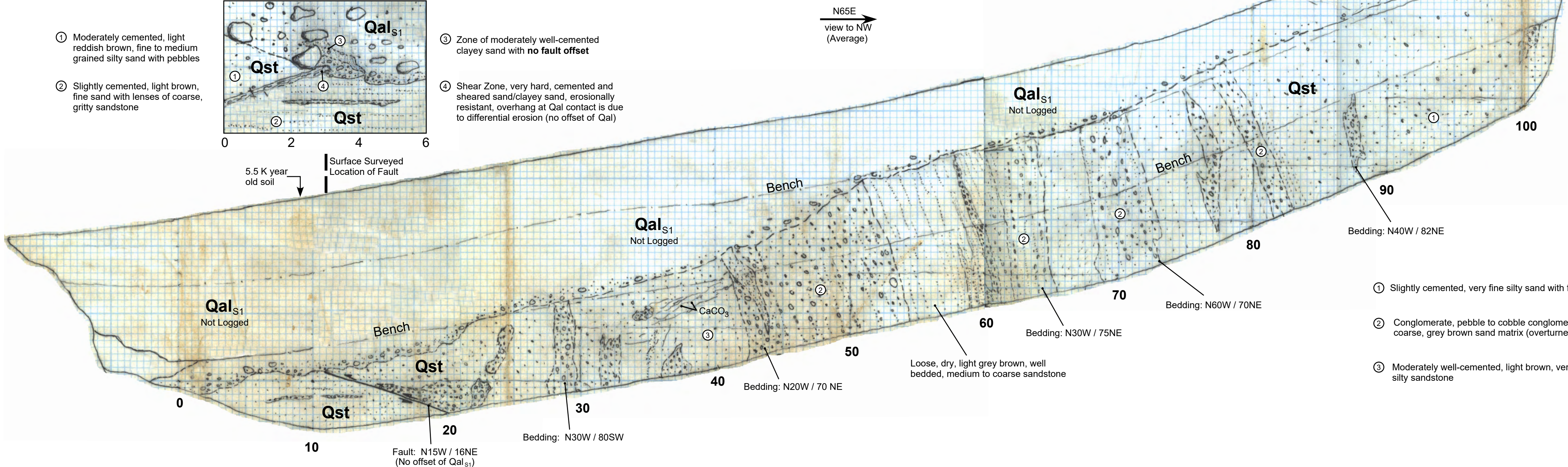
**FT-3b**  
N65E  
view to SE  
Elevation: 2295'  
(5' South of FT-3a and Parallel; STA 0 = STA 68.5 of FT-3A)



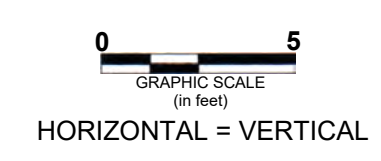
**FT-4**



- ① Moderately cemented, light reddish brown, fine to medium grained silty sand with pebbles
- ② Slightly cemented, light brown, fine sand with lenses of coarse, gritty sandstone
- ③ Zone of moderately well-cemented clayey sand with no fault offset
- ④ Shear Zone, very hard, cemented and sheared sand/clayey sand, erosionally resistant, overhang at Qal contact is due to differential erosion (no offset of Qal)



- ① Slightly cemented, very fine silty sand with few pebbles and grit
- ② Conglomerate, pebble to cobble conglomerate with coarse, grey brown sand matrix (overturned throughout trench)
- ③ Moderately well-cemented, light brown, very fine silty sandstone



**FT-2 thru FT-**

**PETRA GEOTECHNICAL, INC.**  
1225 WORLD TRADE DRIVE, SUITE P  
SAN DIEGO, CALIFORNIA 92128  
SAN DIEGO MURETTA LOS ANGELES COSTA MESA  
PHONE: (858) 485-6000

**FAULT TRENCH EXPLORATION LOGS**  
Fiesta Development  
Calimesa, CA

DATE	10/2004	J.N.	238-04
DWG BY:	DBS	SCALE:	1" = 5'

**PLATE 3**