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DOCKET 09-AFC-8	
DATE	FEB 08 2010
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Letter of Transmittal

February 8, 2010

To: Dockets Unit
CEC
1516 9th Street, MS-4
Sacramento, CA 95814

From: Mike Tietze
WorleyParsons
2330 E. Bidwell St. Ste. 150
Folsom, CA 95630
916-817-3973

RE: Docket 09-AFC-8

To: Dockers Unit

Tracy Craig from our office dropped of binders and a CD of the Aeolian Transport Evaluation and Ancient Shoreline Delineation Report at your office today. We were advised that the CD could not be located by your staff. Enclosed please find a copy of the original CD.

Please feel free to contact me with any questions or concerns at (916) 817-3973.

Sincerely,

Mike Tietze
Project Manager

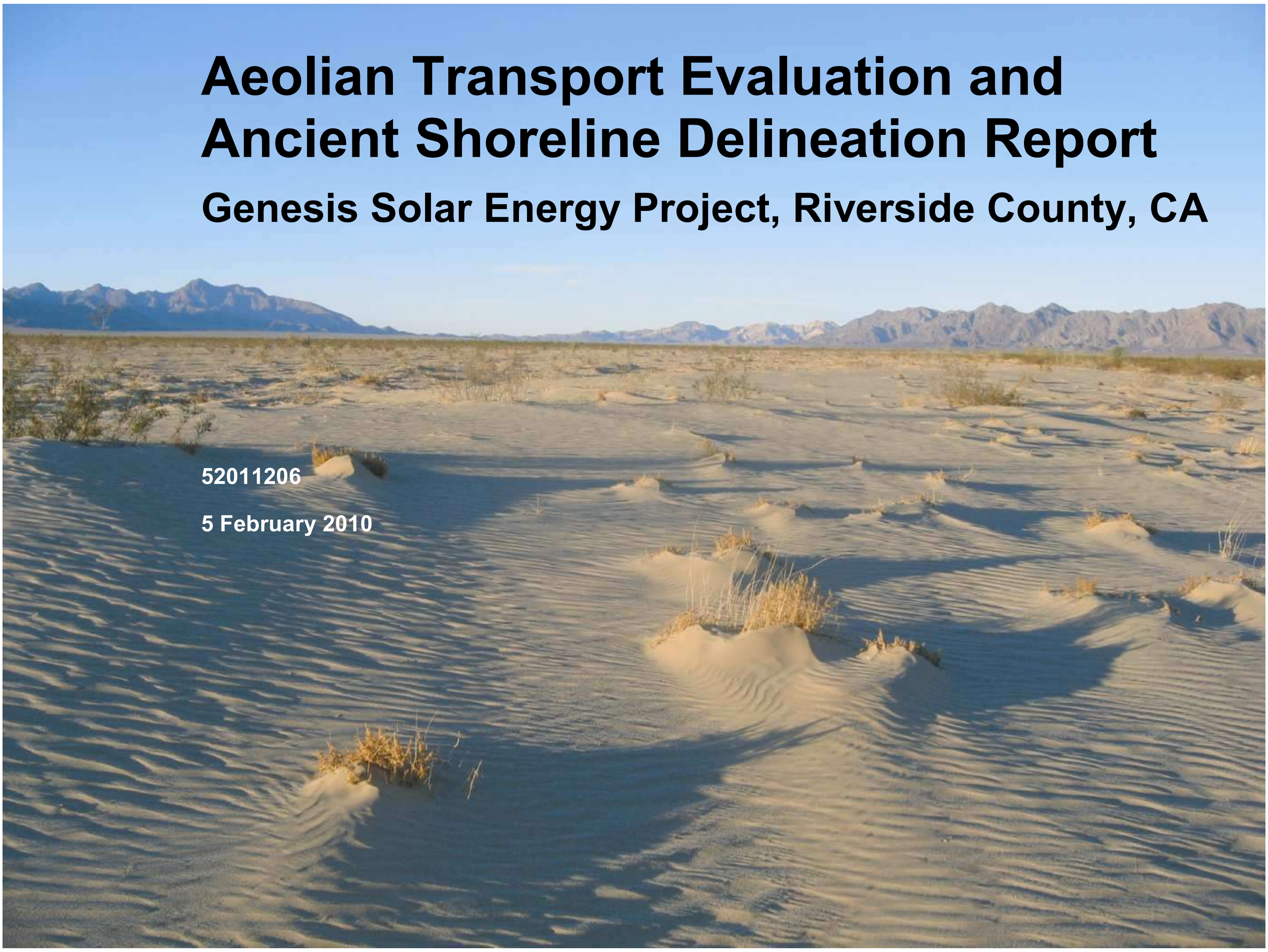
WorleyParsons
resources & energy

EcoNomics

GENESIS SOLAR, LLC

Aeolian Transport Evaluation and Ancient Shoreline Delineation Report

Genesis Solar Energy Project, Riverside County, CA



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5 February 2010

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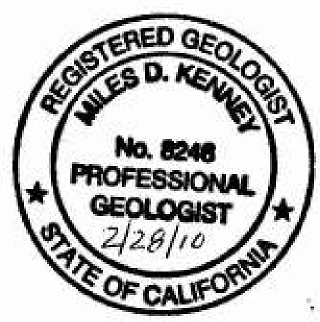
Miles Kenney, a California Professional Geologist and Certified Engineering Geologist, as an employee of WorleyParsons, with expertise in geomorphology, has reviewed the report with the title "Aeolian Transport Evaluation and Ancient Shoreline Delineation Report, Genesis Solar Energy Project, Riverside County, California." His signature and stamp appear below.



Miles Kenney, Ph.D., PG
Professional Geologist 8246

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PROJECT 52011206 - AEOLIAN TRANSPORT EVALUATION AND ANCIENT SHORELINE DELINEATION REPORT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Inernal Review Draft	Miles Kenney	M. Pappalardo A. Karl; E. Festger K. Stein	Mike Tietze	4-Feb-10	Kenny Stein	4-Feb-10
B	Final	Miles Kenney	Mike Tietze	Mike Tietze	5-Feb-10		5-Feb-10

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GLOSSARY OF TERMS

AEOLIAN: Wind Blown. Aeolus was ruler of the winds in Greek mythology.

AGGRADATION: An increase in land elevation due to the **DEPOSITION** of sediment. Aggradation occurs in areas in which the supply of sediment is greater than the amount of material that the system is able to **TRANSPORT**. For example, sand dunes will undergo aggradation if the supply of aeolian sand is greater than the flux of sand out of the system.

COPPICE DUNES: Vegetated sand mounds that are commonly scattered throughout sand sheets in semiarid regions where shrubs and blowing sand are abundant. Any shrub sticking up into the airborne stream of sand is an impediment to the flow, and the resulting turbulence and speed losses cause sand grains to settle out on the downwind side of the shrub and around its base. Coppice dunes range from about 0.5 to 3 m in height and from 1 to 15 m in breadth. Within any given field of coppice dunes, however, the dune size tends towards uniformity. Under certain conditions, individuals or clusters of dunes can become very large and are called vegetation mounds. Because the sand accumulates in piles around the plants and is swept from the surfaces between the plants, a hummocky, rough topography develops that is very different from the smooth, flat, and locally gentle undulatory surfaces of sand plains that are devoid of vegetation and are frequently barren, typically have firm, trough like, scoured surfaces of hard-packed soil, with thin patches of rippled sand or granules (Desert Processes Working Group).

Most active coppice dunes in the Chuckwalla Valley region exhibit “coppice tails” on the leeward side (downwind side) of the coppice mound at the base of the plant. The tails are triangular in shape and with the wide end attached to the plant sand mound and points (narrows) downwind from the plant. The coppice tails are generally 3-inches to 3 feet long and provide excellent wind vector data for approximately graded time (past 1 to 10 years). In addition, a lack of active coppice tails and degraded and/or vegetated coppice mounds at the base of plants is an excellent indicator that sand is not currently migrating within that area.

CORRIDOR SYSTEM (AEOLIAN): An aeolian corridor system pertains to aeolian sand pathways extending for tens of miles and involving numerous subbasins within the Mojave Desert. Regarding the site, a number of studies have identified the Dale Lake to Mule Mountains sand corridor system that allows wind blown sand to travel approximately 70 miles toward the east via topographic valleys and playa lake basins (Palen and Ford Dry Lakes). Our study has identified that the simple single sand corridor is from Dale Lake to the north end of the Mule Mountains is also fed by considerable sand from north to south valleys as well (Palen Valley to Palen Dry Lake and the Palen-McCoy Valley which feeds the eastern end of Ford Dry Lake).

CYCLIC TEMPORAL AND SPATIAL SCALE: Cyclic scale includes a temporal scale involving periods of 10^3 to 10^5 years and spatial scale corresponding to that of large dune field areas (Lancaster, 1995). For this study, Cyclic scale involved the formation of the most of the larger dunes within the Chuckwalla aeolian system that took thousands of years during major aggradational events of the latest Pleistocene and mid Holocene.

GRADED TEMPORAL AND SPATIAL SCALE: Graded scale time is a temporal scale involving periods of 1 to 10^2 years and particularly concerns the dynamics and morphology of dunes, which tend towards an actual or partial equilibrium with respect to rates and directions of sand movements generated by surface winds (Lancaster, N., 1995). Aeolian structures or deposits that may have formed or existed between 1 to less than approximately 1000 years is considered to have formed during graded time. For example within this study, graded time structures include small active dunes and medium to relatively larger size active coppice dunes and their respective tails. In addition, graded special scale involves aeolian processes as the migration of individual dunes within a dune system.

HOLOCENE EPOCH: The Holocene is a geological epoch which began approximately 11,700 years ago (10,000 ^{14}C years ago). According to traditional geological thinking, the Holocene continues to the present.

INSTANTANEOUS TEMPORAL AND SPATIAL SCALE: Instantaneous temporal and spatial scale involves very short to instantaneous periods of time and small areas. Some examples of aeolian structures that form within instantaneous scale involve the formation of sand ripples that can develop in a few minutes and very small coppice dune tails behind shrubs.

INTERDUNE: Interdune areas of the desert floor occur between individual dunes in fields. Closed interdune areas may be poorly drained, contain playas and are typically flat. Where dry and floored by sandy sediment, they have many of the same characteristics as sand sheets. If near-surface moisture is present, interdune areas may contain grasses, shrubs, trees, or even settlements. Interdune areas range in size from a few to tens of square kilometers. In any given locality, the sizes and shapes of the interdune areas are similar, as are those of the intervening dunes

LEE (leeward side of a dune): The leeward side of a sand dune is down wind from the dominant resultant wind direction primarily responsible for its form. The lee side of an individual dune exists between the crest and the base of the avalanche face. On active dunes (Qsa), many active dunes exhibit a free avalanche face where sand sediment is deposited near the angle of repose. (related term – Stoss)

LINEAR DUNES: One of the most common dune types, linear dunes are generally straight to irregularly sinuous, elongate, sand ridges of loose, well-sorted, very fine to medium sand. The straight varieties are often called "sand ridges," and the sinuous varieties are often called "seifs." The lengths of individual dunes, which are much greater than the widths, can range from a few meters to many kilometers. They form in at least two environmental settings: where winds of bimodal direction blow across loose sand, and also where single-direction winds blow over sediment that is locally stabilized, be it through vegetation, sediment cohesion or topographic shelter from the winds. The latter is likely the mechanism of the linear dunes just east of the Genesis Solar Power Plant array.

Linear dunes have formed in areas now characterized by wide ranges of wind speeds and directions. Most are probably "fossil" dunes formed under more vigorous wind regimes during Pleistocene climatic conditions. Since then, wind regimes have apparently become less intense, although wind directions are apparently similar. Thus, where linear dunes are active today, they are commonly being modified into compound or complex features by the addition of secondary dunes. Nonetheless, the long axes of linear dunes are aligned generally within 15° of the prevailing wind or with the resultant drift direction of the local winds. The sinuosity and alternate slip faces develop because crosswinds change direction and alternately shepherd the sand to each side of the dune axes. Long standing opinion on linear dune migration is parallel and along the downwind axis of the dune. However, new evidence is emerging that indicates that linear dunes move oblique to the axis of the dune in the primary direction of the resulting wind drift direction which is often approximately 15° oblique to the dune axis.

PARABOLIC DUNES: In plan view, these are U-shaped or V-shaped mounds of well-sorted, very fine to medium sand with elongated arms that extend upwind behind the central part of the dune (opposite of Barchan dunes). Slip faces occur on the outer (convex) side of the nose of the dune and on the outside slopes of its elongated arms.

Parabolic dunes are always associated with vegetation--grasses, shrubs, and occasional trees, which anchor the trailing arms. In inland deserts, parabolic dunes commonly originate and extend downwind from blowouts in sand sheets only partly anchored by vegetation. They can also originate from beach sands and extend inland into vegetated areas in coastal zones and on shores of large lakes. Coppice dunes are commonly associated with parabolic dune fields. They are frequently found on sand sheets and on and around larger parabolic dunes.

Most parabolic dunes do not grow to heights greater than a few tens of meters except at their forward portions, where sand piles up as its advance is halted or slowed by surrounding vegetation. Parabolic dunes, like crescentic dunes (i.e. barchan), are characteristic of areas where strong winds are unidirectional. Although these dunes are found in areas now characterized by variable wind speeds ranging from low to high, the effective winds associated with the growth and migration of both the parabolic and crescentic dunes probably are the most consistent in wind direction. Some parabolic dunes exist south of Wiley Well rest stop (Plate 1).

PLEISTOCENE EPOCH: The Pleistocene is the epoch from 2.588 million to ~12,000 years before present (BP) covering the world's recent period of repeated glaciations. The Pleistocene Epoch is subdivided into Early (2.6 Ma to 781 kya), Middle (781 to 126 kya) and Late (126 to 12 kya). Time boundaries for the Pleistocene Epoch are still debated. Many publications reference the beginning of the Pleistocene at 1.6 Ma; however, this earlier date does not impact the findings in this report. Within this report the term Latest Pleistocene is considered the last 50 to 60 kya of the late Pleistocene described above.

SAND SHEETS: Sand sheets (or plains) are flat or gently undulatory broad floors of tabular wind blown sand deposits derived from accumulating sand ripple migration. The tabular deposits generally range in thickness from a few centimeters to a few meters). Some sand sheets, as in the southwestern U.S., are local deposits that extend only a few square kilometers in and around dune fields, where they are exposed on interdune floors and form the aprons or trailing margins of dune fields and along sand migration corridors.

Sand sheet deposits are composed of gently inclined or nearly horizontal layers, each less than about a centimeter thick, of coarse silt and very fine to medium sand separated by layers, one grain thick, of coarse sand and granules. Unlike dune sand, the unconsolidated sand and granules are closely packed and firm under foot. The surface is protected by a wind abrasion lag, one grain thick, of the coarsest particles that can be shifted by the wind, ranging from coarse sand to pea-size gravel. In any one place, however, the sizes of the lag particles are remarkably uniform, and the lag may be so closely packed that it forms a miniature desert pavement. In the Chuckwalla Valley, the wind abrasion lag often contains small gravel that may have been derived from burrowing animals moving coarser grained alluvial deposits containing gravel to the surface in the past (McAuliffe and McDonald, 1995). The existence of a wind abrasion lag containing gravel from underlying alluvial units suggests that the surface is a minimum of a few thousand years old in order to provide sufficient time for burrowing animals to mix the near surface units over a relatively large area.

Sand sheets in themselves indicate little about wind direction regimes, but the particle size of sand and gravel lag on ripple surfaces seems dependent on the strength of the winds in any given locality. Inactive sand sheet deposits near and at the surface however do provide evidence of past wind sand migration corridors.

STABILIZED DUNES: Sand dunes that are unable to migrate due to vegetation growth on the dune itself are considered stabilized dunes and also referred to as vegetated dunes. These types of dunes often develop due to insufficient aeolian sand input to the dune to allow for growth and migration. Within this study, dune areas mapped as Qsad and Qsr are dominated by stabilized dunes.

STOSS: The stoss side of the dune points toward the direction the dominant resultant wind responsible for the primary dune form originates. The stoss side exists between the toe and the crest of the dune. Thus, the stoss side of a dune is on the upwind side (related term – Lee).

VENTIFACTS: Rocks that have been abraded, pitted, etched, grooved, or polished by wind-driven sand. Ventifacts typically occur on gravel size rocks exposed on the surface to sand bearing wind. Common surfaces containing ventifacts within the Chuckwalla Valley consist of wind abrasion lag deposits and abandoned alluvial fan surfaces. Ventifacts are identified by rounded edges and a soft feel on the gravel side exposed to the atmosphere. Ventifact forms provide information regarding the prevailing wind direction. Triangular faceted ventifacts are believed to indicate multidirectional prevailing wind directions, and mono-direction “linear” ventifacts provide evidence of a dominant uni-direction resultant drift wind direction. However, prevailing wind evaluation of ventifacts should be conducted on homogeneous clasts such as quartzite that does not exhibit internal structures that may produce differential mechanical erosion in orientation close to perpendicular to prevailing wind directions.

EXECUTIVE SUMMARY

The California Energy Commission (CEC) in Data Request Set 1A for the Genesis Solar Energy Project requested that a specific study be conducted to evaluate the potential impact of the proposed development to the aeolian sand system that maintains Mojave Fringe-Toed Lizard habitat (MFTL). The MFTL habitat is characterized by young and maintained aeolian sand deposits consisting of loose sand that allows the fringe-toed lizards to easily burrow into the unconsolidated wind blown sediments. Thirty nine fringe-toed lizards (both Colorado and Mojave species) were identified during biological surveys in 2009, six of which were positively identified as MFTL (Tetra Tech and Karl, 2009).

The proposed development involves a series of solar arrays within a roughly 1,800 acre rectangular shaped parcel and linears (access road, gas line, transmission lines) involving approximately 90 acres. The method of construction is important in assessing the potential impact to MFTL habitat associated with the solar arrays and linears. Solar array construction will involve mass grading that will require drainage to be intercepted up-gradient and routed around the arrays to the down-gradient side of the facility to continue flow. Construction of the linears will involve placement of an underground gas line, electric transmission line towers and an access road. The underground gas lines finish grade will be close to exiting ground surface contours and thus have a minimal affect on aeolian systems. The over head transmission lines will have a minimal effect on aeolian systems and only in areas of the proposed tower foundations. The current design for the proposed access road involves a low relief road close to existing contours that will not adversely affect aeolian sand migration but may require some special design considerations where it crosses existing drainages.

Based on the existing data, the relative magnitude of aeolian sand sources and migration in the region of the Project includes:

- The majority of the region of the proposed solar arrays is not located within aeolian sand migrating corridors and thus will not block wind blown sand within the Ford Dry Lake dune system.
- The southern and eastern most regions of the proposed solar arrays are within the outside regions of aeolian sand migrating corridors but these regions experience a relatively minor magnitude of wind blown sand migration. Thus, development of these areas will not adversely affect local active dune maintenance outside of the proposed development.
- The washes and surface areas within the proposed solar array represent a very minor source of aeolian sand within the local aeolian system. Thus, grading of this region will not adversely affect local dune maintenance outside of the Project.

- The Palen Dry Lake-Chuckwalla aeolian sand migration corridor (PDL-Chuckwalla Valley) is a major source of wind blown sand for the dune system located south of Interstate Highway 10. Thus, most of the aeolian migrating sand from the PDL-Chuckwalla valley axis passes south of, and does not reach, the Project.

- Ford Dry Lake proper is a minor to moderate source of aeolian sand for the region of the linears. The aeolian sand is derived from Ford Dry Lake proper that is eroded by dominantly eastwardly moving winds from existing sediments on the playa floor.

- The aeolian sand corridor along the eastern side of the Palen-McCoy Valley (Plates 1 and 2) is a major aeolian sand source feeding the dune system east of the solar array and linears. Over 95% of the sand migrating within this corridor moves east of the proposed solar arrays and is not derived from, or passes through, the proposed solar arrays.

- Local washes located along the rim of Ford Dry Lake proper represent a minor source of aeolian sand to the regions bounding the linears and south of the solar arrays.

In conclusion, the proposed Genesis Solar Energy Project directly affects a very small area of potential MFTL habitat, and will not adversely affect the long term maintenance of existing MFTL habitat located outside of the Project.

1 INTRODUCTION

Genesis Solar, LLC (Genesis Solar) is proposing to develop a 250-megawatt (MW) solar thermal power generating facility located in Riverside County, California, between the cities of Desert Center and Blythe on land managed by the Bureau of Land Management (BLM). The proposed Genesis Solar Energy Project (Project) would consist of two 125-MW units. Genesis Solar has applied for a 4,640-acre right-of-way (ROW) grant from the BLM for Project development; however, once constructed, the facility would occupy approximately 1,800 acres within the requested ROW, plus an approximately 90 acres for linear facilities. The Project involves development of a primary Solar Array field and Linears (access road, gas and transmission lines; Plate 1).

This report addresses Data Request Numbers 58, 59 and 60 submitted by California Energy Commission (CEC) Staff to Genesis Solar LLC representatives regarding potential impacts on Mojave fringe-toed lizard (MFTL) habitat by the proposed Project. These Data Requests were primarily related to the direct and long term potential impacts of the proposed facilities on MFTL habitat, and primarily concern aeolian sand deposits, sources, and migration. In addition, geomorphic research was conducted to address questions regarding the temporal and spatial behavior of ancient playa lakes within the Ford Dry Lake (FDL) basin. These findings are provided as a separate preliminary report in Appendix A.

Two primary questions must be addressed to assess potential direct impact to and long term maintenance of MFTL habitat potentially associated with the proposed development:

- What is the direct impact of the proposed development footprint to existing MFTL habitat?
- Would the proposed development produce a sufficient decrease in aeolian sand <u>source</u> to impact existing MFTL? This question involves four factors.
    - What is the source of sand to MFTL habitat?
    - How much aeolian sand is currently generated by the current ground within the proposed footprint of the Project ("intra-washes")?
    - What is the relative significance of a potential decrease in aeolian sand generation by surface water flow re-routed around the proposed solar arrays?
    - Would the proposed development obstruct existing sand migration corridors and, if so, to what degree?

2 SITE PHYSIOGRAPHY

The Project Site lies on a broad, relatively flat, southward sloping surface dominantly underlain by alluvial deposits derived from the Palen Mountains to the north and the McCoy Mountains to the east. The alluvial deposits have created two distinct landform types and several discernable landform ages. The deposits immediately adjacent to the mountains have formed alluvial fans from multiple identifiable sources, and multiple fan surfaces have coalesced into a single bajada surface that wraps around each of these mountain fronts. Between the bajada surfaces from each mountain chain lies a broad valley-axial drainage that extends southward between the mountains and drains to the Ford Dry Lake playa, located about 1 mile south of the Site. The Site itself is relatively flat and generally slopes from north to south with elevations of approximately 400 to 370 feet above mean sea level (amsl). It is occupied by a community of low creosote and bursage scrub vegetation.

The off-site linears extend southeastward from the Project site, skirting ½ to 1 mile northeast of Ford Dry Lake, reach the low point of the valley approximately 1 mile east of Ford Dry Lake, and follow the low point of the valley eastward to near the intersection of I-10 and Wiley's Well Road. The proposed transmission line then crosses I-10 and extends southward, up the lower portions of the southern valley flank, to join the Blythe Energy Transmission Line (currently under construction). The topography crossed by the off-site linears is virtually level, and ranges between 360 and 390 feet amsl. Northeast of Ford Dry Lake, the off-site linears cross an alluvial and aeolian plain that represents the distal portions of the valley axial and bajada surfaces that extend southward from the McCoy Mountains. The ground surface in this area slopes very gently to the southwest, toward Ford Dry Lake, at inclinations of approximately ½ percent. Landforms include alluvial and sand plains, local coppice dunes, and local subdued bar and swale topography associated with sheet flood deposits. East of Ford Dry Lake, the off-site linears cross the distal portions of a valley axial drainage that enters Ford Dry Lake from the east. The ground surface in this area slopes westward at less than ½ percent and the alluvial and the aeolian plain in this area includes similar landforms as described above.

3 METHODOLOGY

The information presented in this report is primarily based on review of existing literature, field mapping, evaluation of high-resolution orthophotographs, soil profile analysis, thin section analysis, field photographs, and utilization of publically available aerial imagery. These are discussed individually below.

3.1 Literature Review

Reviewed literature is listed in the reference section of this report, and included information from studies regarding regional sand migration corridors, types of sources for dune systems in the Mojave Desert Geomorphic Province, and age of aggradational events of dune fields in the southwestern United States. No local dune studies have been identified for the Chuckwalla Valley sand dune system; however, some studies do refer to the "Dale Lake to Mule Mountains sand corridor system."

3.2 Field Mapping

Field mapping was conducted during seven days throughout the Chuckwalla Valley with an emphasis on the vicinity of the Project site (Plate 3). Field work provided the majority of the data utilized in this report concerning the type and age of aeolian deposits, areas of active sand transport, and characterizing areas containing active, dormant and relict dune fields.

3.3 Evaluation of High Resolution Orthophotographs

A series of high resolution orthophotographs were reviewed during the course of this study. The images were of sufficient resolution to identify active coppice dune tails that were at least 3 feet in length. Some source areas from washes the location of linear dunes could also be readily identified.

3.4 Numerically Dated Desert Soils from the Coachella Valley

Previous large scale fault investigations covering more than 6000 acres within the eastern Coachella Valley (Petra, 2007a, 2007b) were overseen by the primary investigator (Dr. Miles Kenney). These studies were located 80 miles due west of the Genesis project site within Coachella Fan alluvial deposits shed from the Little San Bernardino Mountains. As part of the latter studies, numerous soil profiles were evaluated on a morphostratigraphic series of late Pleistocene to Holocene age preserved fan surfaces. The soils within fan deposits represent a chronosequence or a group of soil variables such as topography, parent material, vegetation, and climate that are roughly equal (Jenny, 1941). These soil descriptions and ages were utilized to provide minimum preliminary soil profile ages within this study. This is discussed further in following sections.

3.5 Thin Section Analysis

Twelve dune sand samples were collected within the Palen Dry Lake to Ford Dry Lake sand corridor system and submitted for petrographic examination and X-Ray Diffraction (XRD) quantitative analysis. The analysis was conducted by Applied Petrographic Services, Inc. Their report is attached as Appendix B. All twelve samples were collected within the upper 2 inches of aeolian sand. XRD quantitative analysis was conducted on all 12 samples, and a petrographic analysis utilizing a petrographic microscope was conducted six samples. Sample locations are shown on Plate 4a.

3.6 Publically-Available Satellite Imagery

Google Earth is a free internet program provided by Google. The program allows for evaluation of photographic images of the surface of the earth with scale and location. Locations are provided with latitude, longitude and elevation.

3.7 Site Photographs

Photographs were taken during field mapping at nearly every site visited. Selected photographs with interpretation are provided on Plates 6 through 24. The locations of the selected photographs are shown on Plate 5.

4 REGIONAL GEOLOGY AND GEOMORPHOLOGY

4.1 General Geomorphology of the Basin and Range Geomorphic Province

The proposed development exists within the Mojave Desert Geomorphic Province. Geomorphic provinces are naturally defined geologic areas with a distinct landscape or landform resulting primarily from their predominant underlying geologic structure. The southeast portion of this province, where the Project site is located, is physiographically part of the Sonoran Desert, which includes the lower Colorado River region of southeastern California and extends into southern Arizona. The Mojave Desert Geomorphic Province exists within the larger Basin and Range Geomorphic Province (BRGP), with which it shares a strikingly similar geologic history and resulting geomorphology. For the purposes of this site evaluation, the use of the term BRGP will include the Mojave Desert Geomorphic Province. The geomorphology of the BRGP is dominated by mountains and valleys produced during dramatic tectonic extension in the western and southwestern United States primarily during the mid to late Tertiary (Nelson, 1981; Armstrong, 1982; Rehrig, 1982; Hamilton, 1982; Anderson, 1988; Wernicke, 1992). The lithospheric tectonic extension caused normal faulting in the brittle upper crust allowing for crustal thinning and produced fault bounded mountain ranges (horsts) and valleys (grabens) across the BRGP. The crustal extension led to the development of widespread Tertiary fanglomerates and abundant pressure release volcanism. Many of these deposits associated with the widespread extension were subsequently tilted, folded and faulted post formation during the ongoing extensional tectonism.

The mountains bounding the Chuckwalla Valley near the site are primarily composed of igneous, metamorphic and volcanic rocks. These mountains ranges include the Palen to the north-northwest, the McCoy to the north-northeast, the Mule to the southeast, and the Little Chuckwalla to the south. Numerous basement constrained faults are exposed in the mountain basement rock terranes dominantly associated with Mesozoic compression and Tertiary extensional tectonics. These faults do not displace Quaternary deposits and no active faults are known to exist within the Chuckwalla Valley area (Jennings, 1994). Thus, there is little evidence to suggest Holocene age or even late Pleistocene age tectonic vertical movements have occurred in the region. Typical geomorphic terranes within the BRGP include mountains flanked by an apron of alluvial fans (proximal, middle and distal facies), and playa lakes (valley sinks). Each of these terranes is discussed in more detail below in addition to a general discussion on weathering processes.

4.2 General Weathering Processes

Erosion is primarily produced by chemical and mechanical weathering processes. Primary structures and composition such as pressure release jointing, fracturing, faults, foliation, and types of silicate minerals all play a role in the ability of the bedrock in the mountains to erode. Water is an important factor in both the weathering and transport of rocks and sediments. Water assists chemical reactions and is a strong control on the amount and type of vegetation. Flowing water is also the dominant mode of transport of the erosional products which move the sediment (bed load and suspended load) down the drainages to be deposited. Wind also has the ability to mobilize sediment and does play a larger role in desert environments; however it is a distant second to water in terms of total mass mobilized.

4.3 Mountain Geomorphic Terranes

Mountains within the BRGP generally have relatively steep slopes, erosional "V"-shaped valleys due to drainage erosional processes, and local escarpments along the mountain edges. Within the BRGP erosional processes dominate within the mountainous terranes. Relatively minor deposition does take place in mountain terranes within the drainages as stream terraces. Primary structures and composition of the rocks such as pressure release jointing, fracturing, faults, foliation and chemical composition all play a role in the ability of the mountain rocks to erode. Water is the dominant form of transport of the erosional products which move the sediment (bed load and suspended load) down the drainages to be deposited.

4.4 Alluvial Fan Geomorphic Terranes

The flanks of most mountains ranges in the BRGP piedmont geomorphic terranes contain alluvial fan deposits derived from sediments from erosion of the local mountains (Dohrenwend et. al., 1991). The fans are derived from flowing water emanating from the mountain valleys. The exit point of the drainage from the mountain front is called the apex. At the apex, the fan drainage is no longer confined to the mountain valley and the channel has the ability to fan out in numerous directions leading to a cumulative "fan" shaped deposit. The fans are dominantly composed of fanglomerates and debris flows in the proximal and mid fan sections, and generally grade to fluvial sands in the distal axial valley fan section. Sediment sizes generally get finer further from the fan apex. Fan deposition rates have varied during the Quaternary. Although the correlation that wetter climates during the Pleistocene glaciations played a role in relatively large aggradational fan events throughout the BRGP is debated, it is likely that the climatic maximums during the ice ages led to periods of increased fan deposition (Bull, 1979; Bull, 1990; Dohrenwend, et. al., 1991; Harvey and Wells, 2003; McFadden et. al. 2003). Drainages within the BRGP exhibited discharge an order of magnitude larger than today during pluvial (glaciations) periods (Morrison, 1991; Dohrenwend, et. al., 1991). One effect of wetter climates of the Pleistocene was likely larger storm strength intensity and frequency that generally caused a shift down slope of the proximal, middle and distal fan facies. Thus, it is common to identify distal fan facies deposited during the Holocene overlying late to latest Pleistocene coarser grained middle fan facies

4.5 Valley Sinks – Desert Playa and Pluvial Lakes

One of the key geomorphic characteristics of the BRGP is that drainages terminate in local or regional valley sinks (i.e. Playa lakes) and not the Pacific Ocean or Sea of Cortez (USGS, 1967). The region truly is a "basin". The Colorado River located east of the site near Blythe terminates in the Sea of Cortez and is thus an exception to the vast majority of drainages in the BRGP. Once the extensional tectonics subsided during the late Tertiary, the uplifted mountains continued to erode without further uplift and the local valleys continued to in-fill with sediment. Thus, since the regional tectonic extension ceased, erosional and depositional processes have dominated the area. Over time the aerial extent of mountain ranges and valleys have decreased and increased respectively as mountains erode and adjacent valleys filled with sediment.

Many of the BRGP valley sinks contained lakes most of which existed during the glacial maximums of the Pleistocene (Morrison, 1991; Reheis, 1999; Reheis, 2005; Castiglia and Fawcett, 2006; Reheis et. al., 2007). A distinction can be made between Pluvial and Playa lakes. Pluvial lakes formed during Pleistocene glacial maximums that existed for thousands of years. Pluvial lakes are also referred to as Perennial Lakes. Playa lakes are ephemeral and thus only last for a short period of time before they dry up. G.I. Smith (Dohrenwend, 1991) provided excellent geologic differences between pluvial and playa lake deposits. Pluvial (perennial) lakes are inferred where: (1) sediment hues are green, yellow, or olive-brown (Munsel Color hues 5GY, 10Y, or 5Y); (2) clasts are well sorted and their sizes range from clay to medium sand; (3) bedding is distinct, thin, or laminar; (4) aquatic fossils are noted; and/or (5) saline layers are absent. Play lake deposits are inferred where: (1) sediment hues are orange or brown (10YR, 5YR0; (2) clasts are poorly sorted and their sizes range from silt to sand; (3) bedding is indistinct, massive, or deltaic; (4) aquatic fossils are absent; and/or (5) saline layers are present. Smith (Dohrenwend, 1991) indicated based on this criteria and deep boring data within Palen and Ford Dry lakes, that both of these basins only contained Playa lake deposits to depths of ~160 meters (bottom of borings).

During the early and late Holocene some valley sinks developed relatively minor pluvial lake stands within the BRGP (Morrison, 1991; Dohrenwend, 1991).

4.6 Aeolian Deposits and Source Areas

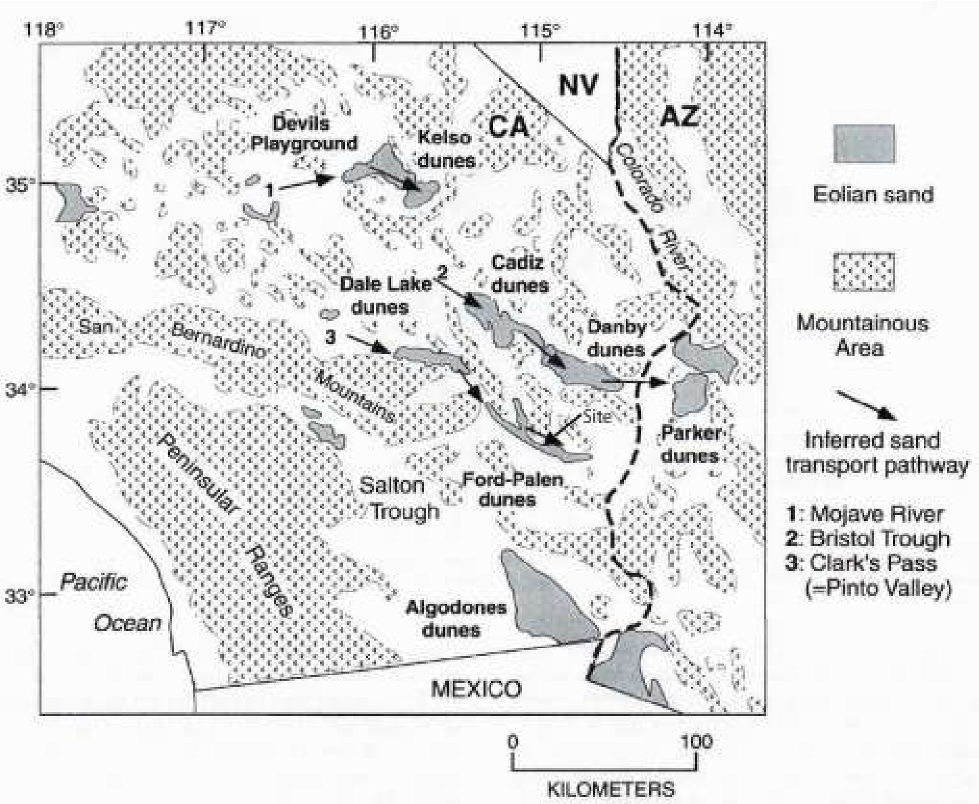
Within the BRGP dune deposition (aggregation-growth) generally occurred during relatively dry periods that dried up pluvial lake basins, following wetter climates that generated considerable sediment supply within regional drainages. (Dohrenwend, et. al., 1991; Lancaster and Tchakerian., 2003). The last major regional sand dune aggradational event occurred near the Holocene-Pleistocene boundary (Dohrenwend, et.al. 1991). However, a global dry period during the mid Holocene (7-5 thousand years (ka) ago) that followed the relatively wetter climate cycle (Forman, et. al., 2001; Jenny et. al., 2002; Fahu et. al., 2003; Umbanhowar et. al., 2006; An et. al., 2006; Jenny et. al., 2002) also allowed for sand dune growth of within the Mojave Desert region 7 to 4 ka (Dohrenwend, et. al., 1991; Lancaster, 1997). In addition, some dune fields in the Mojave Desert observed dune rejuvenation during the 400 years ago (Dohrenwend et. al., 1991, pg. 246; Lancaster, 1997). Most major sand dune deposits existing today in terms of total mass are considered fossil formations as they likely have not actively grown or migrated to a large degree during the late Holocene (Dohrenwend, et. al., 1991).

Most of the sand dunes in the Mojave Desert Geomorphic Province are produced by sand moving east to southeast associated with Pacific Ocean derived weather fronts (see Figure 1). However, this migration is also altered by topographic controls on wind when channeled along mountain fronts and within valleys (Laity, 1987). Although wind data for areas of the Mojave indicate that strong summer monsoonal winds from the south occur, they apparently do not play a large role in terms of large sand transport in the region of the Project. Geomorphic evidence for this is provided by the form of the dunes. For example, well developed barchan dunes clearly indicate that the dominant winds transporting directions.

One method to analyze annual wind data to determine potential sand entrainment and migration direction is the evaluation of the Resultant Drift Potential (RDD). This method requires temporal velocity wind data from throughout the year that obtains data regarding how fast the wind moved and for how long. To determine the RDD, the Drift Potential vector for each wind that occurred during the year exceeding the threshold wind velocity (~12 knots or ~14 miles per hour (mph)) is evaluated which is proportional to the length of time the wind blew greater than the threshold wind velocity (Tsoar, 2004). Thus, an individual DP value and vector is determined for each wind direction that blew greater than the wind threshold velocity. The DP values are proportional to how much stronger it was relative to the threshold wind velocity and how long it blew at those speeds. Adding up all the DP values provides a parameter of the potential maximum amount of sand that could be eroded by the wind during a year for all wind directions (Tsoar, 2004). By adding all the vector units of the DP values provides a resulting vector called the Resultant Drift Potential (RDP). The RDP vector provides a measure of the primary direction of sand transport if there is one. The findings section of this report provides a RDP determined for the Blythe Airport located at the eastern end of the Chuckwalla Valley.

Three primary aeolian sand corridor systems have been identified in the regional BRGP (Zimbelman et. al., 1995; Clarke and Rendell, 1998). These include: Along the Mojave River from the Devils Playground to the Kelso Dunes; The Bristol Trough system which extends southeast from the Bristol Playa to the Colorado River and the Clarks Pass system that extends from Dale Dry Lake to just east of Ford Dry Lake (Figure 1 below; also see Muhs et al., 2003; Lancaster and Tchakerian, 2003).

Figure 1 - Primary aeolian sand migration corridors in the Mojave Desert Geomorphic Province



The source for sand dune sediment within most BRGP dune fields likely comes from a combination of regional sand corridors, playa lakes and local active washes along the sand corridors. Recent work suggests that sediment for most dune fields in the BRGP west of the Colorado River is originally derived from active washes (both locally and regionally along the sand corridors), migration along sand corridors, and transport from dry playa lakes (Lancaster and Tchakerian, 2003; Muhs et. al., 2003; Ramsey et. al., 1999). However, it is clear from review of available literature that site specific studies typically need to be conducted within dune fields to identify the relative contribution from these sources. For example, a study by Muhs et. al. (2003) found that dune fields on opposite sides of the Colorado River are mineralogically distinct and have different sources. They identified that the Parker Dune field located just east of the Colorado River and northeast of the site is supplied by sediment derived from the Colorado River valley itself and not transport of sand from the Danby dune field located west of the Colorado River valley. The Muhs et al. (2003) study indicated that large washes can be both a large source of sediment for dune fields, and also a large impediment to sand wind entrainment.

4.7 Drainage Systems

The BRGP primarily exhibits braided drainage systems containing abundant coarse grained sediment bed load associated with an arid region. Drainages typically begin in the mountainous regions, then extend over alluvial fans and terminate in valley sinks (often playa lakes). Drainages within the mountains typically exhibit V-shaped eroded valleys due to slope erosion and drainage down cutting. Mountainous areas are thus primarily regions dominated by erosional processes and tributary drainage networks. As the drainages exit the mountain front they enter the region dominated by alluvial fans at the fan apex geomorphically referred to as piedmonts. Piedmonts consist of coalescing alluvial fans exhibiting a mosaic of active channels, abandoned channel segments, and interchannel surfaces or ridges (Dohrenwend, et. al., 1991). Active piedmont drainages form distributary drainage networks in areas of recent active fan deposition (current active washes) with bar and swale topography. Abandoned portions of piedmonts typically exhibit tributary drainage networks on areas of older fan deposition across relict abandoned fan surfaces. The vast majority of coarse grained sand and gravel transported by the local drainages is deposited within the alluvial fans. Near the termination of the alluvial fan system drainages become progressively less constrained within distinct channels which allows for sheet flow type deposition to occur. Eventually the drainages reach a valley terminal sink which generally represents a playa lake of nearly horizontal fine grained strata (silts and clays).

5 FINDINGS

5.1 Site Geology and Geomorphology

The Project site exists within the distal fan portion of a series of alluvial fans and bajadas flanking the east side of the Palen Mountains to the north and northwest of the Project site, and the southwestern side of the McCoy Mountains to the northeast (Plate 1). The piedmont bajadas merge within an approximately northward trending axial valley between the Palen and McCoy Mountains (referred to herein as the Palen-McCoy Valley) that terminates in Ford Dry Lake. Topographically, the area of the proposed Project solar array and linear facilities are relatively flat, with an approximately 0.3 degree southwest slope and exhibits surficial sediments composed of silty sands with lesser amounts of fine grained gravel. The Project site exhibits relatively thin alluvium, relict dune and current drainage deposits overlying older alluvium across most of the site above an elevation of 377 feet amsl (See report in Appendix A). Below an elevation of approximate 377 feet amsl, the thin layer of alluvium, relict dune and current drainage deposits overly latest Pleistocene lacustrine deposits.

Preserved late to latest Pleistocene age alluvial fan surfaces (Qoaf) with well developed desert surfaces (desert pavement, soil profiles) are still preserved at the surface near and within a limited area in the northwestern part of the Project site (Plate 3). Proximal and upper mid-fan facies occur along the flanks of the local mountains to the northwest and northeast (Plate 3). These preserved fan surfaces were developed during sediment aggradational events that occurred during wetter climates of the Pleistocene ice ages and have been eroding since the latest Pleistocene (Weldon, 1986; McFadden and Weldon, 1987; Bull, 1990; Harvey and Wells, 2003; McDonald et. al., 2003). The latest Pleistocene alluvial fan deposits exposed along the flanks of the Palen and McCoy mountains represent the same coarse grained deposits as those observed within 1 to 2 feet of the surface within the Project site (morphostratigraphic relationship).

The subsurface geology at the Project site is dominated by nearly horizontal strata composed of interbedded lacustrine and mid- to distal-fan facies, and possibly sand dune facies. Based on depositional age studies conducted throughout the Mojave Desert, each of these facies generally has depositional maximums that are at least partially climatically controlled (Dohrenwend et. al, 1991). For example, thick lacustrine deposits developed during glacial maximums when valley sinks contained widespread pluvial lakes, sand dune growth occurred during interstitial glacial periods (dryer climate), and maximum alluvial fan aggradation occurred during glacial and interglacial transitions (Morrison, 1991; Dohrenwend et. al., 1991). However, there are typically local exceptions to these general regional climatic controlled depositional cycles.

5.2 Chuckwalla Valley Sinks

The site is located within the Chuckwalla Valley which contains two primary valley sinks. The first is Palen Lake, located about 12 miles west of the Project site, and the second is Ford Dry Lake, located about 1 mile due south of the Project site (Jenkins, 1967). Thus, the drainages emanating from the local mountain ranges and across local alluvial fans terminate within these local sinks. The vast majority of drainages in the BRGP and all of the drainages in the project area are ephemeral (the drainage is usually dry and fills with water only during brief episodes of intense rainfall). As shown on Plate 1, the western portion of Chuckwalla Valley containing Palen Lake trends northwest-southeast (herein the Palen Valley) and then turns to approximately due east-west in the region of Ford Dry Lake. A tributary valley extends northward from the Project site between the Palen and McCoy Mountains (herein the Palen McCoy Valley).

Ford Dry Lake represents the drainage sink for the eastern Chuckwalla Valley watershed, including the area around the Project site, and contains surficial sand dune deposits underlain by ephemeral playa lake deposits (Dohrenwend et. al., 1991). Thick accumulation of lacustrine (lake) deposits generally occurred during the wetter climates of the Pleistocene glacial maximums. Pleistocene lakebed deposits similar to those described northwest of Palen Lake are located north of Ford Dry Lake between the Project site and the playa (DWR, 1963). The age of the most recent major pluvial lakes throughout the Mojave Desert valley sinks is latest Pleistocene (13 to 11 ka); Rehis, 1999; Briggs, 2003; Jayko et. al, 2005; Knott, 2005; Miller, 2005; Beacon et. al., 2005; Reheis, et. al., 2007). Relatively smaller Holocene lakes also occurred within many BRGP valley sinks during the early and early late Holocene (Morrison, 1991; Dohrenwend et. al., 1991).

The elevation of Ford Dry Lake playa is approximately 350 feet amsl, and the maximum upper elevation of the sink (sill) surrounding this sink is approximately 460 above mean sea level, located approximately 10 miles east of the site, at the eastern outlet to Chuckwalla Valley in a pass between the southern McCoy Mountains and northern Mule Mountains. Exposed playa lake deposits (lacustrine deposits - Ql) exist in the valley northwest of the current playa at an upper elevation of approximately 377 feet amsl (see Appendix A).

A geologic map published by the California Department of Water Resources (DWR, 1963) indicates lacustrine deposits at upper elevations of 520 feet amsl west of the site and south of the Palen Mountains. A pluvial lake with surface elevation of ~520 feet amsl suggests that the sill to the east has been eroded more than 60 feet (from 520 to 460 feet amsl) since the time these high standing lacustrine deposits were laid down. This is assuming no local tectonic movements, which is reasonable based on previously discussed information regarding local fault activity. These DWR-mapped lacustrine deposits are overlain with late Pleistocene alluvial fan deposits exhibiting very dark desert varnish.

5.3 Aeolian Aggradational Events Since the Latest Pleistocene

To understand the aeolian system within the Chuckwalla Valley region requires an understanding of the behavior of dune systems in the regional BRGP since the latest Pleistocene (past 13,000 years). Within the Mojave Desert Geomorphic Province, sand dune deposition (aggregation-growth) generally occurred during relatively dry periods following wetter climates that generated considerable sediment supply within regional drainages and dried up pluvial lake basins (Dohrenwend, et. al., 1991; Lancaster and Tchakerian., 2003). The last major regional sand dune aggradational event occurred near the Holocene-Pleistocene boundary (Dohrenwend, et.al. 1991). However, a global dry period during the mid Holocene that followed the relatively wetter climate cycle (Forman, et. al., 2001; Jenny et. al., 2002; Fahu et. al., 2003; Umbanhowar et. al., 2006; An et. al., 2006; Jenny et. al., 2002) also allowed for sand dune growth within the regional BRGP 7 to 4 ka (Dohrenwend, et. al., 1991). Most major sand dune deposits existing today are considered fossil formations as they have likely have not been actively forming during the late Holocene (Dohrenwend, et. al., 1991).

Most of the sand dunes in the regional BRGP are produced by sand moving east to southeast due to resultant annual wind directions dominantly controlled by Pacific winter storms (see Figure 1 in Section 4.6 and Figure 2 in Section 5.5.4). However, this migration is altered by topographic controls on wind when channeled along mountain fronts and within valleys (Laity, 1987). Zombelman et. al. (1995) identified the primary sand corridor system in the area of the Project site that extends from Dale Dry Lake to just east of Ford Dry Lake (Figure 1; also see Lancaster and Tchakerian, 2003). The source for sand dune sediment within most dune fields in the regional BRGP comes from a combination of regional sand corridors, local active washes along the sand corridors and playa dry lakes (Lancaster and Tchakerian, 2003; Muhs et. al., 2003; Ramsey et. al., 1999).

5.4 Sediment Dating Techniques

The age of the geologic units mapped in the vicinity of the Project site was estimated in both approximate numerical and relative terms. Relative ages were assigned by stratigraphic position of the sedimentary layers. In alluvial fan environments, morphostratigraphic relationships may also provide relative ages for alluvial fan deposits. In upper fan reaches the older preserved fan surfaces (terraces) are generally at higher elevations than younger surfaces. In distal areas of the fan, older deposits are typically buried by the younger layers. Numerical ages for sedimentary units may be assigned by careful examination of the soil profiles. For this study, numerical ages for sediments were estimated by correlating site soil profiles with known dated soils in the Coachella Valley (Petra, 2007a and 2007b), and should be considered approximate.

5.4.1 Soil Profile and Geomorphic Surface Development Ages

Soil profiles provide **minimum** dates for sedimentary units. This process estimates the minimum age of the sedimentary units based on the degree of soil profile (pedon) development at the uppermost portion of the unit and for buried soil profiles within the unit. Of primary importance is that soil profiles do not provide the age of sediments, instead, they reflect when deposition ceased and prolonged exposure of the sediments to near-surface weathering processes was initiated. A rough depositional age can be arrived at by the sum of cumulative ages of the uppermost soil pedon and all buried pedons within the unit(s). Desert soils are typically dated utilizing the Soil Development Index (SDI) method of Harding (1982). With an SDI value, a soil in question may be compared to other regional soils evaluated with the same method and dated with absolute techniques such as Carbon-14.

Empirically, SDI values have shown strong correlations to soil age (Harding, 1982; Rockwell et al., 1985; Reheis et al., 1990; Rockwell, et al., 1994; and Helms et al., 2003).

Selected photographs of site soils and fan surfaces are provided on Plates 11A and B, 12A and B, 17(A and B), 18 (all), 19A, 20B and 24(A and B).

5.4.2 Morphostratigraphic Age Correlation

Morphostratigraphic units are the correlation of fill terrace fan deposits (soil age), into the drainages where the same units are buried by younger fan deposits. In theory stratigraphically deeper fan deposits preserved beneath younger sediments in lower elevations may be traced to geomorphically higher positions at the proximal part of the fan system. This correlation is critical because it permits the transfer of numerical soil profile ages determined for the preserved fan surfaces (soil ages) to buried depositional units at lower elevations.

5.5 Geologic Stratigraphy

Field mapping in the vicinity of the Project site yielded a local stratigraphy of seven units. Stratigraphic relationships between geologic layers and analysis of preserved soil profiles in turn generated relative and numerical minimum ages for each unit. Results of the mapping are provided on Plates 1, 2 and 3. The order of unit descriptions provided below first provides those units deposited by flowing water (alluvial or lacustrine), which are followed by descriptions of units deposited by wind (aeolian). Colors included in the unit descriptions were determined in the field utilizing the Munsell Soil Color Charts (Hue Value/Chroma).

5.5.1 Alluvial and Playa Lake Units

Qw: Active wash deposits composed of very fine to very coarse sand with small gravel, light brown (7.5YR 6/3 dry) to yellowish brown (10YR 5/4 dry), and loose. This unit is confined within the active washes and is typically 1 to 6 inches thick in most washes, but may locally be greater than 2 feet thick in some of the larger washes. This unit was not mapped within the Project site. This unit is the youngest mapped in the area. Selected photographs of Qw deposits include Plates 13(A, B, and C) and 20(A and B).

Qal: Quaternary Alluvium exists across most of the site and is composed of unconsolidated very fine to coarse sand with small gravels, brown (7.5YR 5/3 dry), moderate to well bedded, and loose. This unit typically exhibits an upper member soil Bw horizon ranging in age from 1 to 3 ka (soil designation S3a this report) which commonly overlies buried soils within unit Qal some of which are estimated to be 7 to 8 ka old (soil designation S3a). The soil bearing portions of the unit are generally light yellowish brown (10YR 6/4 dry) to light brown (7.5YR 6/4 dry, 5/4 damp). Smooth gravel lag surfaces overly the older members of this unit. This unit typically overlies older alluvium above elevation 374’ amsl, or lake deposits below Elevation 374 feet amsl (the approximate elevation of latest Pleistocene shoreline). Unit Qal appears to be a tabular sedimentary body that extends over the vast majority of the Project (Solar Array and Linears) with an average thickness of 1 foot (see Cross Section A-A' in Appendix B). Selected photographs of Qal deposits include Plates 9(A and B), 10(A and B), 11(A and B), 22(A and B), and 24(A and B).

Ql: Lake deposits associated with an ancient playa. Unit Ql is light yellowish brown (10YR 6/4 dry), very fine to medium sandy silt, medium dense to dense, iron oxide stained, massive, medium dense to dense, blocky, and with a densely jointed texture likely due to desiccation cracks. No fossils were encountered during this study. Selected photographs of Ql deposits include Plates 8(C), 9(A and B), 19(A and B), 20(B), 22(A and B), and 24(A and B).

Qoaf: Older alluvial fan deposits likely associated with regional aggradational depositional events associated with major Pleistocene glaciations. The unit is ubiquitous across the site in the near surface except for below an elevation of 374 feet amsl (old shore line) where it may exist at depth. These deposits are distal fan facies consisting of silty fine to very coarse sand with small to medium dense and massive gravels. Unit bears multiple surface soils and paleosols that may be subdivided into additional members. The youngest soil is a minimum 12 to 20 ka old (soil designation S4), and a second common soil is estimated to be older than 20 ka at a minimum. Selected photographs of Qoaf deposits include Plates 10(A), 12(A and B), 17(A and B), and 18(all).

5.5.2 Aeolian Units

Mapping current active areas of wind blown sand deposits in the Ford Dry Lake region is problematic because Chuckwalla Valley has experienced a greatly reduced rate of wind blown sand migration and deposition during the latest Holocene compared to periods during the latest Pleistocene to late Holocene. Thus, many areas contain near surface sand deposits of latest Pleistocene to late Holocene age that are currently stabilized with vegetation and wind blown lag deposits. Most of the areas with current active wind blown sand transport have occupied the same location since the latest Pleistocene, but current sand supply is only sufficient to produce limited areas of active aeolian deposition within these areas (Plates 1 and 2). The aerial extent of active dunes in the past covered a larger region than during the latest Holocene. Most of these areas now exhibit moderately to strongly stabilized dunes even within current sand migration corridors and only limited areas within the active sand migration corridors exhibit active dunes. Map units Qsa, Qsad, and Qsr (described below) were selected to discern relative magnitudes of the wind blown sand input and deposition in the vicinity of the Project site (see Plates 1, 2 and 3).

Qsa: Unit Qsa represents active aeolian sand deposits that exhibit loose sand, leeward side avalanche faces, sand sheets (deposits from migrating ripples), and/or active coppice dunes with tails. Relative large regional areas dominated by unit Qsa are primarily located in Palen Lake and east of Wiley's Well Road (Plate 1). The Palen Dune Field exists within and adjacent to Palen Lake and exhibits abundant active dunes (barchan – concentric and transverse). Dominant graded scale resultant wind directions are from the northwest and roughly parallel to the Chuckwalla Valley axis based on the orientation of the dunes. Active barchan dunes in the Palen Dune Field migrate toward the east-south east (Dohrenwend, et. al., 1991). Relatively small areas of unit Qsa occur east of the proposed Project solar arrays and linears (Plate 3) and are maintained by aeolian sand migrating nearly due south along the eastern side of the Palen-McCoy Valley. Nearly all of the Qsa deposits mapped east of the Project site are partially stabilized by vegetation and likely represent a small remnant of a larger dune field that was active during the latest Pleistocene to mid Holocene. Mapped as Qsa east of the Project site are no longer actively growing in size since the latest Holocene.

Unit Qsa is appropriate habitat for the Mojave fringe-toed lizard. The Palen Dune Field (proper) is one of a few BRGP dune fields considered to be active, and thus continuing to grow (Dohrenwend, et. al., 1991). Selected photographs of Qsa deposits include Plates 6(B), 7(A), 14(A background), 15(A and B), 16(A and B), 19(B), 20(A-Borderline Qsa-Qsad deposits flanking channel), and 21(A and B).

Qsad: Aeolian sand migration and depositional area dominated by latest Pleistocene to late Holocene stabilized dunes. These deposits exhibit current sand transport with isolated areas exhibiting wind blown sand deposition (sand sheets, coppice and avalanche face of linear dunes). Much of the area within the broader mapped Qsad units does not exhibit loose sand on the surface and would more properly fall under the definition of unit Qsr, described below. Small isolated areas of within mapped Qsad also fall under the definition of unit Qsa, above. Selected photographs of Qsad deposits include Plates 6(A and B), 8(A and B), 9(A and B), 13(A, B and C), 14(A), 15(A and B), 16(B), 20(A-Borderline Qsa-Qsad deposits flanking channel), 21(A and B), and 23(A, B and C).

Qsr: Relict aeolian sand sheet and degrading coppice dune sediments with very limited to no active sand transport or deposition. These sediments were deposited within wind transport and depositional areas during the Holocene and are no longer active. Deposits consist of very fine to fine sand that are strong brown (7.5YR 6/5 damp), massive to poorly bedded, and loose. Similar to unit Qal, this unit commonly exhibits soil horizons in the upper 2 to 6 inches that range in age from 1 to 7 ka old, and exhibit a very coarse sand to gravel lag at the surface that is similar to desert pavement but is the result of wind abrasion. Unit Qsr is a common unit exposed on the surface and overlies unit Qal as a tabular sedimentary deposit averaging 4 to 8" thick in sand sheet areas (the most common occurrence of this unit). These deposits are typically strongly stabilized with grasses, creosote and wind-generated abrasion lag deposits of very coarse sand to small gravel. Selected photographs of Qsad deposits include Plates 7(B), 9(A and B), 14(A, B and C), 21(A and B), and 24(A).

5.5.3 Soil Profile Stratigraphy

For this study, a series of soil designations were developed that provide a preliminary soil pedon stratigraphy for the site. The designations are indented to provide a minimum age range for the observed soils, and thus, minimum ages for the time of abandonment of the surface to the near surface soil-forming processes. A detailed soils profile analysis was not conducted at the site, and the designated age ranges are therefore minimum, (conservative) values for the soils identified. The soil designations and estimated age ranges are listed in the following table.

Soil Designation	Estimated Age	Description
S0	<1000 years (1 ka)	No soil development.
S1	1 to 3 ka	No desert varnish, weak surface gravel packing; 1/8" Av horizon, weak cambic Bw horizon typically to 3" depth (strong brown 7.5YR 5.6 dry). Entisol.
S2	3 to 5 ka	Weak desert pavement and no to very slight desert varnish, slightly perceptible rubification, 1/16" thick carbonate rings along clast-surface contact, slight softening of clast surfaces from wind abrasion, 1/4" to1/2" thick gray to light yellowish brown (10YR 6/4 dry) Av and deepening Cambic Bw horizons (3 to 4 inches), minor secondary minerals, penetrative carbonate, Stage I-, slight hardening of B horizon.
S3a	5 to 8 ka	Weak to moderately developed desert pavement and varnish, faint but clearly visible rubification, carbonate rings along clast-surface contact, softening of exposed clast surfaces from wind abrasion, ¼" pink (7.5YR 7/3 dry) Av horizon, Reddish Brown (5YR 7/3 dry) Bw horizon in parent fine grained sandy silt deposits to light yellowish brown (10YR 6/4 dry) to light brown (7.5YR 6/4 dry) in gravelly sand parent material, medium dense, blocky, iron oxide staining along vertical joints, Bwk horizon within 8" to 10" of surface, visible stage I- to I carbonate stringers-concentrations.
S3b	8 - 12 ka	Moderate developed desert pavement, moderate desert varnish, carbonate rings along clast-surface contact, softening of clast edges by wind abrasion, ¼" pink (5YR 7/3 dry) Av horizon, 3" thick reddish yellow (5YR 6/6 dry) Bt with secondary clay, 5" thick light reddish brown (5YR 6/4 dry to damp) blocky Btk horizon with minimum stage I carbonate stringers, and horizontal Bk horizons.
S4	12 - 20 ka	Moderate to well developed desert varnish and pavement, ¼" to 1 ½" pink (5YR 7/3 dry) Av horizon, Bt horizon: 4 to 8 inches thick, yellowish red (5YR 5/6 dry) thick, numerous vertical joints filled with Av material spaced at 3 to 8 inches and extending 3 to 6 inches deep, medium dense to dense, pinhole porosity, carbonate in upper 3 inches, secondary clay, clay ped bridging with blocky structure from 8 to 13 inch depth, in places Btk horizons as filaments to 1/8 inch diameter concretions in fine grained parent materials and crude parallel to surface carbonate lamellae in coarse grained parent materials, carbonate on underneath side of clasts, typically becomes very dense at 8 inches to 1 foot depth with continuation of the Bt horizon. Thus, lower limits of soil rarely fully excavated within site test pits (exceeds bottom of pit).
S5	>20 ka but likely within latest Pleistocene	Well developed surface where not eroded away; Bt is yellowish red (2.5 -7.5YR 5/6 dry, 4/6 moist, Btk with stage II carbonate, 1/4 to 1/2 inch diameter carbonate concretions, dense, blocky, secondary clay abundant in Bt horizon, soil profile a minimum of 2 feet thick.

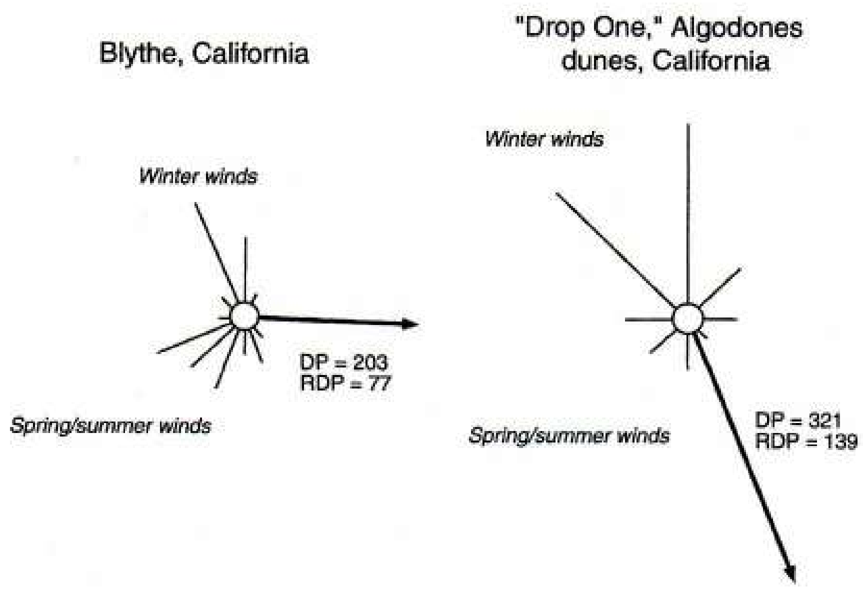
Selected photographs of site soils and fan surfaces are provided on Plates 11A and B, 12A and B, 17(A and B), 18 (all), 19A, 20B and 24(A and B).

5.5.4 Prevailing Wind Regime in the Chuckwalla Valley (Resultant Drift Potential)

Annual and seasonal wind rose diagrams data from Blythe (ASOS data), which is located approximately 25 miles east of the Project site, just east of Chuckwalla Valley (Plate 1), indicate two dominant wind directions during typical years. During the Spring and Summer months, the strongest winds are from the south associated with monsoonal storm events. During the Fall and Winter, the strongest winds are from the north-north west associated with Pacific Ocean derived weather fronts. Determining the primary wind direction responsible for sand migration can be evaluated by geomorphic mapping of dune types, orientations, and locations, which is described later in the report, and by determining the Resultant Drift Potential (RDP) from appropriate wind data (Toar, 2004).

Muhs, et. al. (1995) determined the RDP for the Chuckwalla Valley to Blythe region for wind data collected at the Blythe Airport. Figure 2 below from Muhs, et. al., (1995) determined a RDP for the Blythe Airport that points nearly due east, parallel to the Chuckwalla Valley (left diagram).

Figure 2 – Resultant Drift Potential (RDP) Data from Blythe and the Algodones Regions.



The Algodones dune field is located at the south end of the Salton Trough. These data indicate that Pacific Cell winter storm fronts in combination with topographic effects (mountains and valleys) dominate the orientation of the RDP at Algodones.

The nearly due east resultant vector RDP for the Blythe airport located near the eastern outlet of the Chuckwalla Valley (on Palo Verde Mesa) is very consistent with indicators of dominant wind direction and sand migration observed during the field mapping performed in the Project site vicinity for this study in the axis of Chuckwalla Valley. This is discussed in more detail in the next section.

5.5.5 Major Local Aeolian Sand Migration Corridors

Major aeolian sand migration corridors were identified in the Chuckwalla Valley region by review of the literature, mapping areas of relatively young aeolian deposits, local dune structures, observations of migrating sand during wind events, and performing a sand provenance study. These are discussed below.

5.5.5.1 Review of the Literature

A number of published reports indentify an aeolian sand migration corridor oriented approximately along the axis of Chuckwalla Valley (Dohrenwend, et al., 1991; Lancaster and Tchakerian, 2003; Muhs et al., 2003). These regional aeolian system studies indicated that the prevailing wind responsible for aeolian sand transport was from the northwest toward the southeast and locally controlled by topography (mountain ranges). Muhs et al. (1991) also identified the a sand migration corridor along Palen Valley between the Coxcomb and Palen Mountains (Plate 1).

5.5.5.2 Mapping of Young Aeolian Deposits

Observation and mapping of aeolian deposits provide excellent data indicating the level of activity of local sand migration. Mapping in the Chuckwalla Valley with an emphasis on the Project area was conducted identifying aeolian deposits of various activity levels. Units Qsa, Qsad and Qsr provided criteria with a decreasing level of migrating aeolian sand activity, respectively. The results of this mapping are provided on Plates 1, 2 and 3. Many photographs of aeolian deposits in the region are also provided (see Plates 5 through 24). Qsa regions generally exhibit active sand ripples, active dunes and loose surficial sand at least a few inches thick. Mapped Qsad represents areas of active sand migration but exhibit a wide range of aeolian deposit types including active (minor Qsa areas), moderately active and inactive (Qsr). Qsr regions exhibit older aeolian deposits that are degrading or strongly stabilized.

5.5.5.3 Local Dune Structures (Wind Vectors)

Aeolian geomorphic structures provide excellent data regarding the dominant direction of aeolian sand transport for different time scales. Prevailing wind direction indicators (wind vectors) for aeolian systems include sand ripples, dune types, coppice dune tails, and ventifacts. Each of these is discussed below.

5.5.5.3.1 Sand Ripples

Migrating aeolian sand ripples develop nearly perpendicular to the current wind. The ripples form nearly instantaneously and thus active surface ripples only provide information regarding the current or most recent strong wind direction.

5.5.5.3.2 Dune Types (Transverse and Linear)

Two primary types of dunes were identified during this study which include transverse and linear. These types of dunes are of substantial size that requires decades to hundreds of years for their development (graded time) and thus provide excellent long term information regarding the prevailing wind directions (RDP). Transverse dunes, which include barchan dunes, generally form perpendicular to the regional prevailing winds (RDP) and linear dunes form within approximately 15 degrees from the prevailing wind or multiple dominant wind directions (mixed). Although debated, the linear dunes in the study areas appear to migrate within approximately 15 degrees from long axis direction.

5.5.5.3.3 Coppice Dune Tails

Coppice dunes that develop at the base of shrubs provide excellent data prevailing wind data on a graded scale. In areas of active sand migration, coppice dune tails form on the leeward side of the coppice dune and thus provided excellent prevailing wind direction data and evidence of active sand migration in the area. In contrast, degraded to strongly degraded stabilized coppice dunes without evidence of coppice dune tails provide good data indicating a lack of active sand transport in a region. The identification of varies levels of coppice dune activity in the study area was a critical criteria for determining the level and direction of prevailing aeolian sand migration directions and magnitudes.

5.5.5.3.4 Ventifact on Quaternary Older Alluvial Fan Surfaces

Ventifacts represent surface rocks or outcrops that have been eroded by the abrasion associated with sand bearing wind. If the prevailing wind is form a consistent direction, then rocks on the surface can sometimes form erosional structures roughly parallel to the wind. Internal structure of the exposed ventifact rock can place strong controls as well on the orientation of the abrasion structure. Ventifacts considered useful for providing prevailing long term wind direction in this report were identified on late Pleistocene alluvial fan surfaces and were composed of homogeneous clasts like non-foliated quartzite.

5.5.6 Field Observations of Migrating Aeolian Sand

Field observations during storm wind events associated with a typical winter major storm from the Pacific Ocean were conducted on December 22 and 23, 2009. Migrating aeolian sand and a fine grained dust cloud were observed and provided direct evidence of aeolian sand migration in the Chuckwalla Valley. Aeolian sand was observed migrating at various locations, with a direction of migration that is consistent with the wind vectors, dune structures, and major aeolian sand migration corridors shown on Plates 1, 2 and 3.

It was observed that the aeolian sand was transported a minimum of 6 feet above the ground surface and had no difficulty migrating across an entrenched dirt road (Plate 6 – Photo A), across paved roads elevated on a shoulder berm (Plate 7 – Photo A; Plate 8 – Photo A), an older alluvial Fan surfaces (unit Qoaf; Plate 8 – Photo C).

Aeolian sand and a fine grained dust cloud that rose hundreds of feet into the air was also observed travelling down the axis of the Chuckwalla Valley from Palen Lake across Interstate Highway 10 approximately 3 to 4 miles west of the Wiley Well rest stop (Plate 8 – Photo B). This same dust cloud was also observed to slowly migrate toward the north and head across the center of Ford Dry Lake playa as the winds died down in the late afternoon.

A discussion with two Cal-Trans workers on January 12, 2010 provided excellent information regarding the dominant aeolian sand migration direction at that site during the past 5 years. Both workers indicated that they have been responsible for removing aeolian sand from Interstate Highway 10 between Blythe and Desert Center, including from the Wiley's Well rest stop area, for the past 5 to 7 years. The workers indicated that aeolian sand at the Wiley's Well rest stop dominantly comes from the north (Palen-McCoy Valley) and that is the reason trees were planted on the north side of the rest stop facility. They also indicated that toward the west from the Wiley Well rest stop, considerable aeolian sand migrates diagonally across Interstate Highway 10 diagonally in the area south of Ford Dry Lake. These observations are consistent with the identified major aeolian sand migration corridors down the axis of Chuckwalla Valley and from the Palen-McCoy Valley as shown on Plates 1 and 2.

5.5.7 Regional Aeolian Sand Sources

There are numerous sources of aeolian sand within the Chuckwalla Valley. In the BRGP west of the Colorado River, the primary aeolian sand sources are ephemeral drainages soon after they flow, playa lakes, existing active dune fields within sand migration corridors, and older aeolian deposits. These are discussed below.

5.5.7.1 Ephemeral Drainage Aeolian Sand Source

After a wash flows it exposes potential sand for wind entrainment at the surface. Strong winds within just a few strong wind storms subsequent to drainage flow will entrain most of the available sand (saltation) and begin to move the sand out of the channel. It does not take long for the fresh fluvial sands to form a protective cap composed of very coarse sand and/or gravel as the finer aeolian sands are removed by the wind. After the gravel cap forms, very little additional sand is entrained by the wind from the wash until it flows again. Thus, drainages that flow often will produce substantially more aeolian sand than washes that flow infrequently. Ephemeral washes produced aeolian sand is the dominant source for the Palen-McCoy Valley sand migration corridor east of the proposed solar arrays.

5.5.7.2 Playa Lakes

Eroding playa lake area sediments, many of which also contain older dune deposits, are a major potential source of sand for dune systems due to wind abrasion. Playa lakes will produce an increased amount of aeolian sand soon after they dry up after being in-filled with water from nearby washes and from rain falling on the lake bed surface. Variations in wind directions or strength, or changes in vegetation cover can lead to changes of aeolian sand flux as well. Playa lakes are generally located within the center of basins and bounded by mountain ranges thus causing them to experience some of the strongest prevailing winds in the region. In the region of the Project site linears, both the Palen Lake and Ford Dry Lake are aeolian sand contributors.

5.5.7.3 Active Dune Fields

Active dune fields, especially if located within a major aeolian sand migration corridor, will be a sand source for dune systems along the direction of the prevailing wind. Thus, once sand reaches a major aeolian sand migration corridor, it will begin to migrate within the corridor.

5.5.7.4 Older Aeolian Deposits

If older dune deposits are not maintained by new aeolian sand and also do not become sufficiently stabilized (vegetation, wind abrasion lag), the can fall victim to wind abrasion that allows the sand grains to once again be entrained by the wind. This was easily observed in older dune deposits throughout the Chuckwalla Valley within mapped units Qsr and Qsad.

5.5.8 Local Aeolian Sand Sources (Provenance Study)

Multiple aeolian sand sources were identified for the dune deposits near the proposed Project solar arrays and linears (Plate 2). The relative contribution of different aeolian sand sources to these deposits varies between deposits east of the proposed solar arrays and deposits toward the south in the area of the Project linears. Geomorphic mapping clearly indicates that abundant aeolian sand travels southward along the eastern side of the Palen-McCoy Valley (Plate 1). This sand is dominantly derived from ephemeral drainages that extend from Palen Pass along the eastern side of Palen-McCoy Valley (Plates 1 and 2). The nearly north-south orientation of linear dunes in the eastern Palen McCoy Valley east of the solar array indicates that the resultant wind direction for sand migration is from the north-northwest. Aeolian sand derived from local washes in the eastern Palen-McCoy Valley was observed in the field and identified in aerial photographic images. This sand migration route is designated herein as the Palen-McCoy Valley Sand Corridor (Plate 4a).

The Palen Dune field exists within and adjacent to Palen Lake and exhibits abundant active dunes (barchan – concentric and transverse). Dominant graded scale resultant wind directions based on the orientation of the dunes are from the northwest and roughly parallel to the Chuckwalla Valley axis. Active barchan dunes in the Palen Dune Field migrate toward the east-south east (Dohrenwend, et. al., 1991). This sand migration route is designated herein as the PDL-Chuckwalla Valley Axis Sand Corridor (Plate 4a).

The prevailing winds in the Palen Valley force aeolian sand to migrate southward along the eastern side of that valley in a manner similar to sand migration in the Palen-McCoy Valley described above (Plate 1). This sand migration route is designated herein a the Palen Valley Sand Corridor (Plate 4a).

Southeast of the proposed Project solar array and in the region of the Project linears, the aeolian sand source is dominated by southward migrating sand from the Palen-McCoy Valley. Based on XRD analyses of aeolian sand samples, the aeolian sand reaching the region east of the linears from the PDL-Chuckwalla Valley Axis Sand Corridor is not from the Palen Dune Field area. Plate 4a shows the locations of the analyzed aeolian sand samples and Plates 4b and 4c show ternary compositional diagrams plotting the XRD data. The XRD data (see Appendix B for the analytical report) provides normalized percent compositional values for major mineral composition of the sand grains, including Quartz, Feldspars (Albite, Anorthite, and Microcline), Mica and Clay (Muscovite, Illite, and Kaolinite) and Calcite. These compositional values were then normalized for various ternary compositions as shown on Plates 4b and 4c.

The ternary diagrams show that the aeolian sand compositions for samples collected between Palen Lake and Ford Dry Lake (samples S-17 and S-18) are very similar to those for samples collected from the Palen Dune Field (samples S-40 and S-42). This indicates that sand is migrating from Palen Lake eastward toward the western side of Ford Dry Lake along the Chuckwalla Valley axis. However, the ternary diagrams also indicate a significant compositional difference between aeolian sand samples collected from the Chuckwalla Valley axis on the western side of Ford Dry Lake and samples collected from dunes located at the east end of the Project linears near the Wiley Well rest stop (samples S-1, S-2, S-6 and S-7). This strongly suggests that the dominant source of aeolian sand in the areas east of the Project solar arrays and linears is separate and distinct from the PDL-Chuckwalla Valley Axis Sand Corridor. The XRD data are consistent with geomorphic field observations that wind blown sand migrating southward along the eastern side of the Palen-McCoy Valley along the Palen-McCoy Valley Sand Corridor is the dominant aeolian sand source feeding the dunes located east of the solar array and linears (Plate 2).

The ternary data also indicate a slight difference in composition between samples located east of the solar arrays (samples S-25, S-30, S-31, and S-34) and those collected from dune deposits further south at the east end of the linears (S-1, S-2, S-6 and S-7). The samples collected east of the proposed solar array actually plot compositionally between the samples collected from the PDL-Chuckwalla Valley Axis Sand Corridor and the samples collected from the east end of the Project linears. Thus, this compositional difference does not appear to be associated with aeolian input from the PDL-Chuckwalla Valley Axis Sand Corridor. This strongly suggests that there is a second relatively minor source of aeolian sand entering the dune system east of the linears. Based on the existing data (geomorphic mapping, wind vectors, identified sand migration corridors, etc) the source is most likely associated with ablation from Ford Dry Lake itself.

These data indicate that most aeolian sand that is being transported eastward within the PDL-Chuckwalla Valley Axis Sand Corridor (Plate 1) does not reach the Project site or linears, but instead migrates across Interstate Highway 10 and passes south of the Project site and linears. In addition, the dominant source of sand in the region of the Project linears and to the east of Ford Dry Lake is the Palen-McCoy Valley (the Palen-McCoy Valley Sand Corridor), with a minor local component derived from Ford Dry Lake.

6 CONCLUSIONS

The Chuckwalla Valley is a region of active aeolian sand migration and deposition, but at a magnitude substantially less that it had historically experienced during past dune aggradational events since the latest Pleistocene. In addition, the aerial extent of aeolian activity is moderately less than during past regional dune aggradational events. This can be seen on Plates 1 and 2, where unit Qsr (relict dune fields) extends beyond the northern boundary of the primary sand migration corridor from Palen Lake through the Ford Dry Lake area, and south of the Project solar arrays. In addition, considerable near surface Qsr deposits are identified within interdune regions of mapped aeolian sand migration corridors (mapped unit Qsad on Plates 1 and 2). For the most part, the same sand migration corridors that were active during past dune aggradational events within the Chuckwalla Valley region are still the primary pathways of sand migration.

As shown on Plates 1 and 2, active aeolian sand migration in the Project site vicinity occurs within existing sand migration corridors located south of the Project site and linears (the PDL-Chuckwalla Valley Axis Sand Corridor), and east of the Project site and Ford Dry Lake (the Palen-McCoy Valley Sand Corridor). The vast majority of sand moving within the Palen-McCoy Valley Sand Corridor passes east of the proposed solar array, and a relatively minor component migrates within the easternmost portion of the proposed solar array (see Plate 14 – Photos A, B, and C).

The aeolian sand migration within the eastern-most area of the proposed Project solar array has two sources. These include sand derived from the local small ephemeral washes within the footprint of the proposed facility soon after they flow, and from southward migrating sand moving down the Palen-McCoy Valley Sand Corridor. Based on field mapping, aerial photograph evaluation and evidence that the onsite drainages flow infrequently (estimated to be approximately every 20 years and likely associated with relatively large El Nino events) the aeolian sand derived from the onsite drainages represents a very small component of the total aeolian sand within the Palen-McCoy Valley Sand Corridor system. In addition, the amount of wind-blown sand passing through the eastern-most portion of the proposed Project solar array represents a very minor component to the total aeolian sand migrating in the Palen-McCoy Valley Sand Corridor. Based on the existing data, it is likely that the component of aeolian sand migrating through, or derived in, the eastern-most portion of the Project solar array site is less than 5% of the total wind blown sand migrating within the Palen-McCoy Valley Sand Corridor system. Thus, the affect of developing this area on the source and migration of aeolian sand that maintains the Mojave fringe-toed lizard (MFTL) mapped habitat east of the Project and along the linears is considered minimal.

Aeolian sand sources in the area of the Project linears are complex in that they are within a mixing zone involving the PDL-Chuckwalla Valley Axis and Palen-McCoy Valley Sand Corridors. Orientations of coppice dune tails and linear dunes east of the Project linears, an active migrating set of mixed wind barchan dunes south of the linears, and sand sample compositional analysis strongly suggest that the northerly winds from the Palen-McCoy Valley dominate sand transport in the area surrounding the linears. However, strong winds from N68W from the northern region of the linears (Plate 2) were observed to transport sand and produced 1 to 3 inch long instantaneous ephemeral coppice dune tails on December 22, 2009, which is consistent with a minor episodic aeolian sand source entering the region of the linears from Ford Dry Lake proper. This observation is supported by the results of the XRD analysis of active aeolian sand samples.

Based on the existing data, the following conclusions may be made about the relative contribution of various aeolian sand sources and about sand migration in the region of the Project:

- The majority of the region of the proposed solar arrays is not located within aeolian sand migrating corridors and thus will not block wind blown sand within the Ford Dry Lake dune system.
- The southern and eastern-most regions of the proposed solar arrays are within the outer envelope of an aeolian sand migrating corridor but these regions experience a relatively minor magnitude of wind blown sand migration.
- The washes and surface areas within the proposed solar arrays and linears represent a very minor source of aeolian sand. Thus, proposed grading and development will not remove a significant source of aeolian sand and adversely affect mapped areas of active aeolian deposits.
- The PDL-Chuckwalla Valley Axis Sand Corridor is a major source of wind blown sand for the dune system located south of Interstate Highway 10. Thus, most of the aeolian migrating sand from the Palen Lake-Chuckwalla valley axis does not reach the Project.
- Ford Dry Lake proper is a minor to moderate source of aeolian sand for the region of the Project linears.
- The aeolian sand corridor along the eastern side of the Palen-McCoy Valley (Plates 1 and 2) is a major aeolian sand source feeding the dune system east of the solar array and linears. Over 95% of the migrating aeolian sand in the Palen-McCoy Valley sand corridor migrates east of the proposed Project. Thus, less than 5% of the migrating aeolian sand is estimated to be derived from the area within the proposed solar arrays.
- Local washes located along the rim of Ford Dry Lake proper represent a very minor source of aeolian sand to the regions bounding the linears and south of the solar arrays.

Based on the evaluation of the current data, sand migration to the active dune fields (MFTL habitat) east of the proposed Project solar array and linears will not be adversely affected by the proposed development. Aeolian sand flux to the dunes east of the solar array derives nearly all their sand from the north via the eastern side of the Palen-McCoy Valley. Thus, the existing dunes (i.e. MFTL habitat) will continue to function normally after the Project is built.

Aeolian sand migration was directly observed to occur across low profile man-made structures, rough alluvial fan surfaces, and very hummocky and vegetated topography within the sand migration corridors. In addition, long term CalTrans workers confirmed that aeolian sand is transported across Interstate Highway 10 south of Ford Dry Lake. Aeolian sand migration across the linears will occur during the lifetime of the Project from both northerly and westerly prevailing winds. Therefore, a low profile access road, such as has been proposed as part of the Project design, would not adversely affect aeolian sand transport toward the south and east, as wind blown sand was directly observed to easily transect such structures and to travel at heights of at least six feet.

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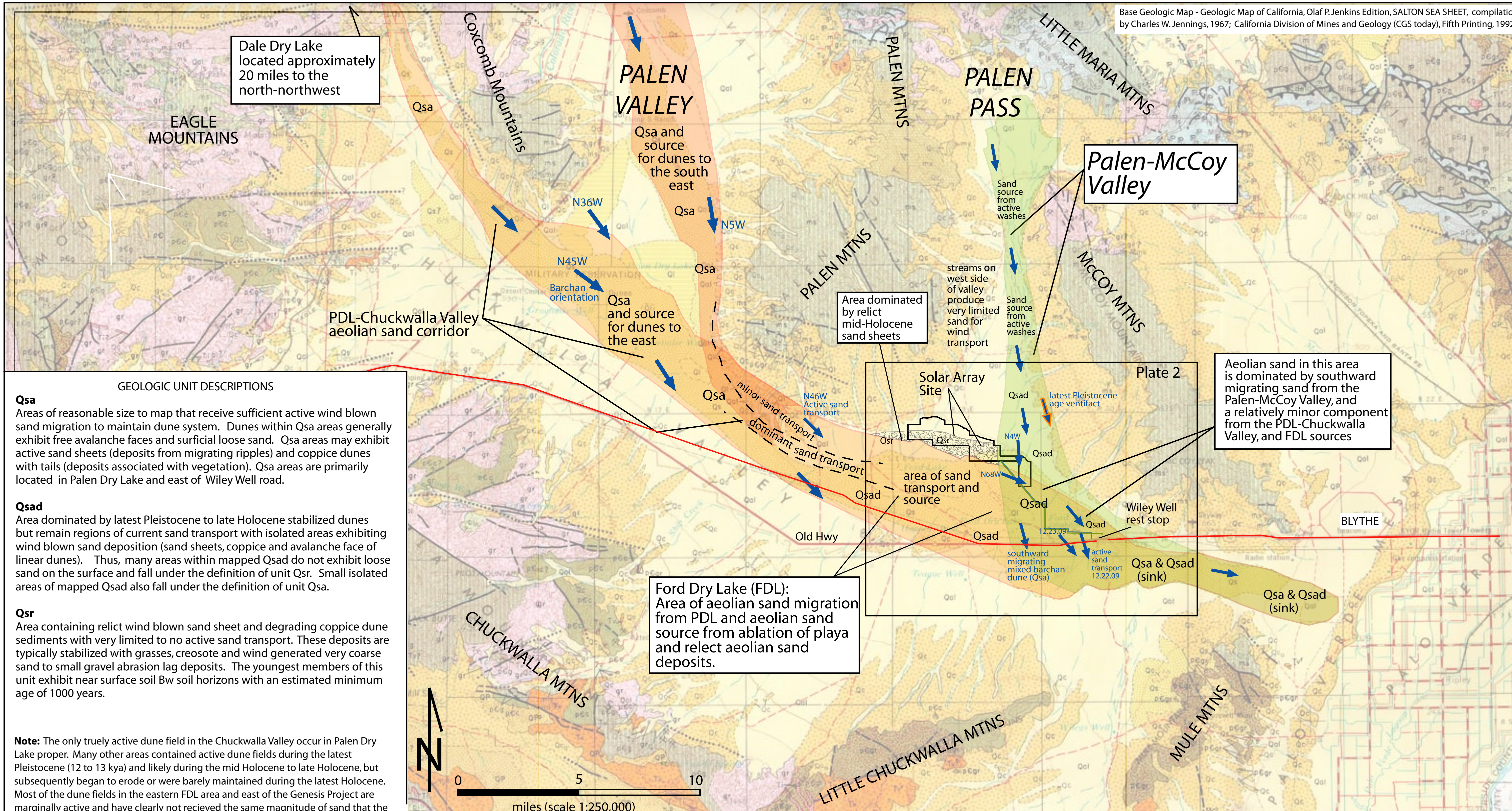


GEOLOGIC UNIT DESCRIPTIONS

Qsa
Areas of reasonable size to map that receive sufficient active wind blown sand migration to maintain dune system. Dunes within Qsa areas generally exhibit free avalanche faces and surficial loose sand. Qsa areas may exhibit active sand sheets (deposits from migrating ripples) and coppice dunes with tails (deposits associated with vegetation). Qsa areas are primarily located in Palen Dry Lake and east of Wiley Well road.

Qsad
Area dominated by latest Pleistocene to late Holocene stabilized dunes but remain regions of current sand transport with isolated areas exhibiting wind blown sand deposition (sand sheets, coppice and avalanche face of linear dunes). Thus, many areas within mapped Qsad do not exhibit loose sand on the surface and fall under the definition of unit Qsr. Small isolated areas of mapped Qsad also fall under the definition of unit Qsa.

Qsr
Area containing relict wind blown sand sheet and degrading coppice dune sediments with very limited to no active sand transport. These deposits are typically stabilized with grasses, creosote and wind generated very coarse sand to small gravel abrasion lag deposits. The youngest members of this unit exhibit near surface soil Bw soil horizons with an estimated minimum age of 1000 years.

Note: The only truely active dune field in the Chuckwalla Valley occur in Palen Dry Lake proper. Many other areas contained active dune fields during the latest Pleistocene (12 to 13 kya) and likely during the mid Holocene to late Holocene, but subsequently began to erode or were barely maintained during the latest Holocene. Most of the dune fields in the eastern FDL area and east of the Genesis Project are marginally active and have clearly not recieved the same magnitude of sand that the area once did prior to the mid Holocene and older aggradational events. Minor late to latest Holocene dune growth events may have occured in the region but were minor relative to earlier periods of deposition (also see **Note** of Plate 2)

Approximate current limits of the active wind sand transport corridor from the Palan Dry Lake region down the Chuckwalla Valley. Dominant resultant sand movement toward the east.

Approximate current limits of the active wind sand transport corridor from the Palen Pass region down the Palen and McCoy Mountain Valley. Dominant resultant sand movement toward the south-southeast.

N20W

Wind direction vector measured in the field. Directions based on coppice tails (graded scale of 1 to 10 years), barchan and Linear dunes (cyclic scale - thousands of years), and ventifacts in rocks on late Pleistocene surfaces. Note, vector directions were not obtained from instaneously forming ripple directions, however, active ripples were very generally very consistent with older wind direction indicators. Orientation indicates direction the wind is from.

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
Generalized Aeolian Sand Migration Corridors and Depositional Areas, Genesis Solar Energy Project, Chuckwalla Valley, California	MK	MT	2/2010
	52011206		Plate 1

SYMBOL DESCRIPTIONS

Qal Quaternary Alluvium consisting of fluvial distal fan deposits. Within the site these deposits are composed of fine to very coarse sand and small gravel, well bedded and generally only 6-inches to 2-feet thick. Soil horizons indicate that the deposits are between 1ky to approximately 8 ky old.

Qsa Areas of reasonable size to map that receive sufficient active wind blown sand migration to maintain dune system. Dunes within Qsa areas generally exhibit free avalanche faces and surficial loose sand. Qsa areas may exhibit active sand sheets (deposits from migrating ripples) and coppice dunes with tails (deposits associated with vegetation). Qsa areas are primarily located in Palen Dry Lake and east of Wiley Well road. Limited areas of Qsa occur east of the Genesis Power site.

Qsad Area dominated by latest Pleistocene to late Holocene stabilized dunes but remain regions of current sand transport with isolated areas exhibiting wind blown sand deposition (sand sheets, coppice and avalanche face of linear dunes). Thus, many areas within mapped Qsad do not exhibit loose sand on the surface and fall under the definition of unit Qsr. Small isolated areas of mapped Qsad also fall under the definition of unit Qsa.

Qsr Area containing relict wind blown sand sheet and degrading coppice dune sediments with very limited to no active sand transport. These deposits are typically stabilized with grasses, creosote and wind generated very coarse sand to small gravel abrasion lag deposits. The youngest members of this unit exhibit near surface soil Bw soil horizons with an estimated minimum age of 1000 years.

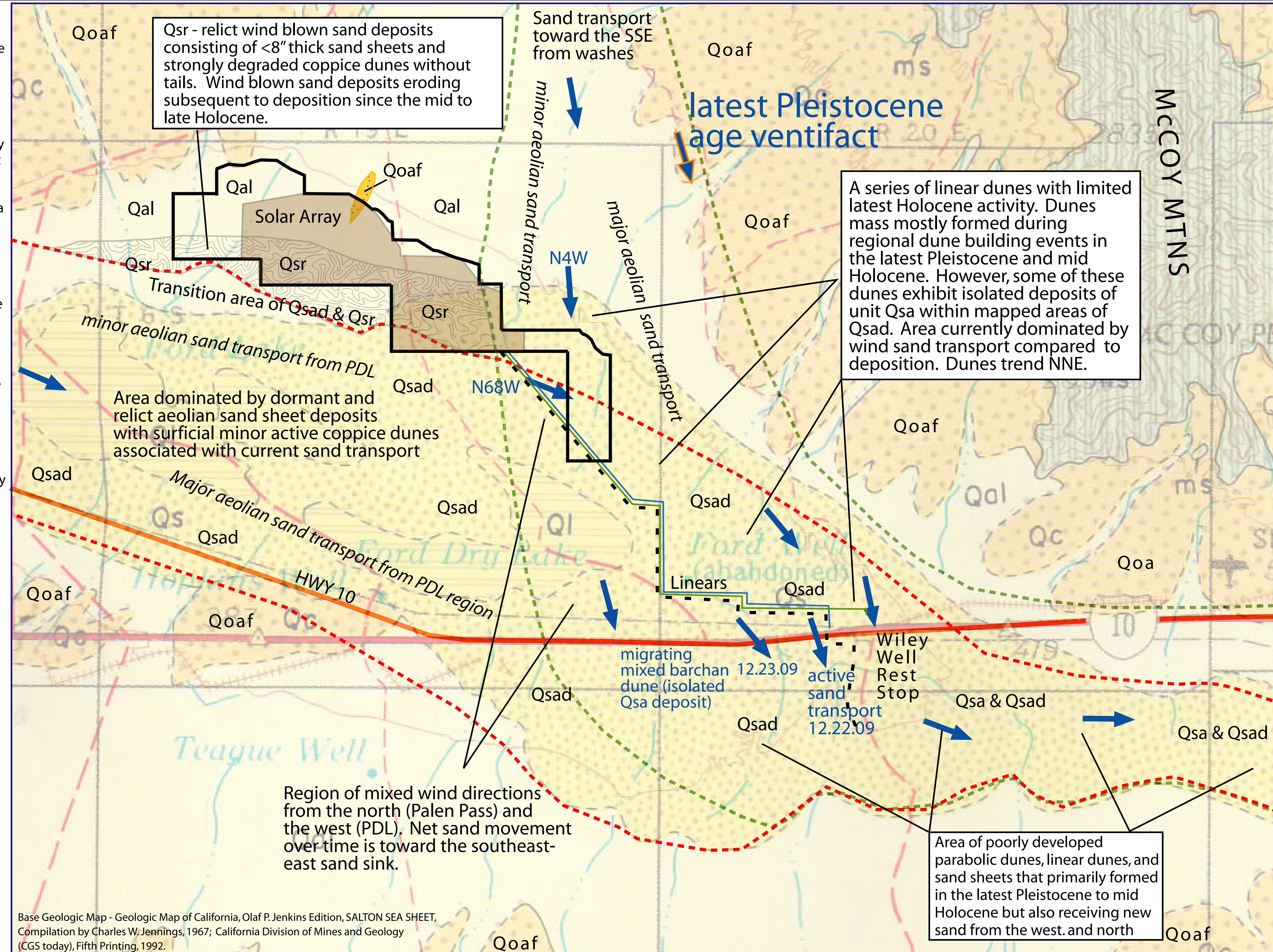
Qoaf Latest Pleistocene Alluvial fan deposits. They are composed silty fine to very coarse sand and minor small gravel. The unit is generally within 1 to 2 feet of the surface within the Project Solar Array site and exhibits a pedogenic soil horizon sequence that is likely a minimum of latest Pleistocene age.

Note: Mapping current active areas of wind blown sand deposits in the Ford Dry Lake region is problematical. This is because the region of the Chuckwalla Valley during the latest Holocene has experienced a greatly reduced rate of wind blown sand migration and deposition compared to periods during the latest Pleistocene to late Holocene. Thus many areas contain near surface sand deposits of latest Pleistocene to late Holocene age that are currently stabilized with vegetation and wind blown lag deposits. Most current active areas of wind blown sand transport continue to occur in the same regions since the latest Pleistocene but sand supply is only sufficient to produce limited areas of active wind blown sand deposition within these areas (Qsad). Sand transport and migration terms Qsa, Qsad, and Qsr attempt to discern relative magnitudes of the wind blown sand input and deposition. Qsa depicts areas of reasonable size to map that receive sufficient sand input to maintain an active dune field. Qsad represents an region that is dominated by older stabilized dunes but is within a wind blown sand migration corridor to maintain limited areas of surficial active wind blown sand deposition (thin sand sheets, coppice dunes, and linear dunes). Qsr depicts regions that were once an area of wind blown sand migration and relatively minor deposition during the latest Pleistocene to late Holocene, but are dominantly no longer receiving sufficent wind blown sand to result in sand deposition.

N20W — Wind direction vector measured in the field. Directions based on coppice tails (graded scale of 1 to 10 years), barchan and Linear dunes (cyclic scale - thousands of years), and ventifacts in rocks on late Pleistocene surfaces. Note, vector directions were not obtained from instantaneously forming ripple directions, however, active ripples were very generally very consistent with older wind direction indicators. Orientation indicates direction the wind is from.

Approximate limits of aeolian sand migration corridor from Palen Dry Lake (PDL) region toward the east along the Chuckwalla Valley (PDL-Chuckwallay Valley).

Approximet limts of aeolian sand migration corridor from Palen Pass toward the south between the Palen and McCoy Mountains. (Palen-McCoy Valley)



N

0 miles (scale 1:250,000) 5

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Generalized Local Sand Migration Corridors and Depositional Areas - Proposed Genesis Solar Energy Project, Chuckwalla Valley, California

MK	MT	2/2010
52011206	Plate 2	

Linear Symbol Description

- Proposed Gas Line
- Proposed Transmission Line
- Proposed Access Road

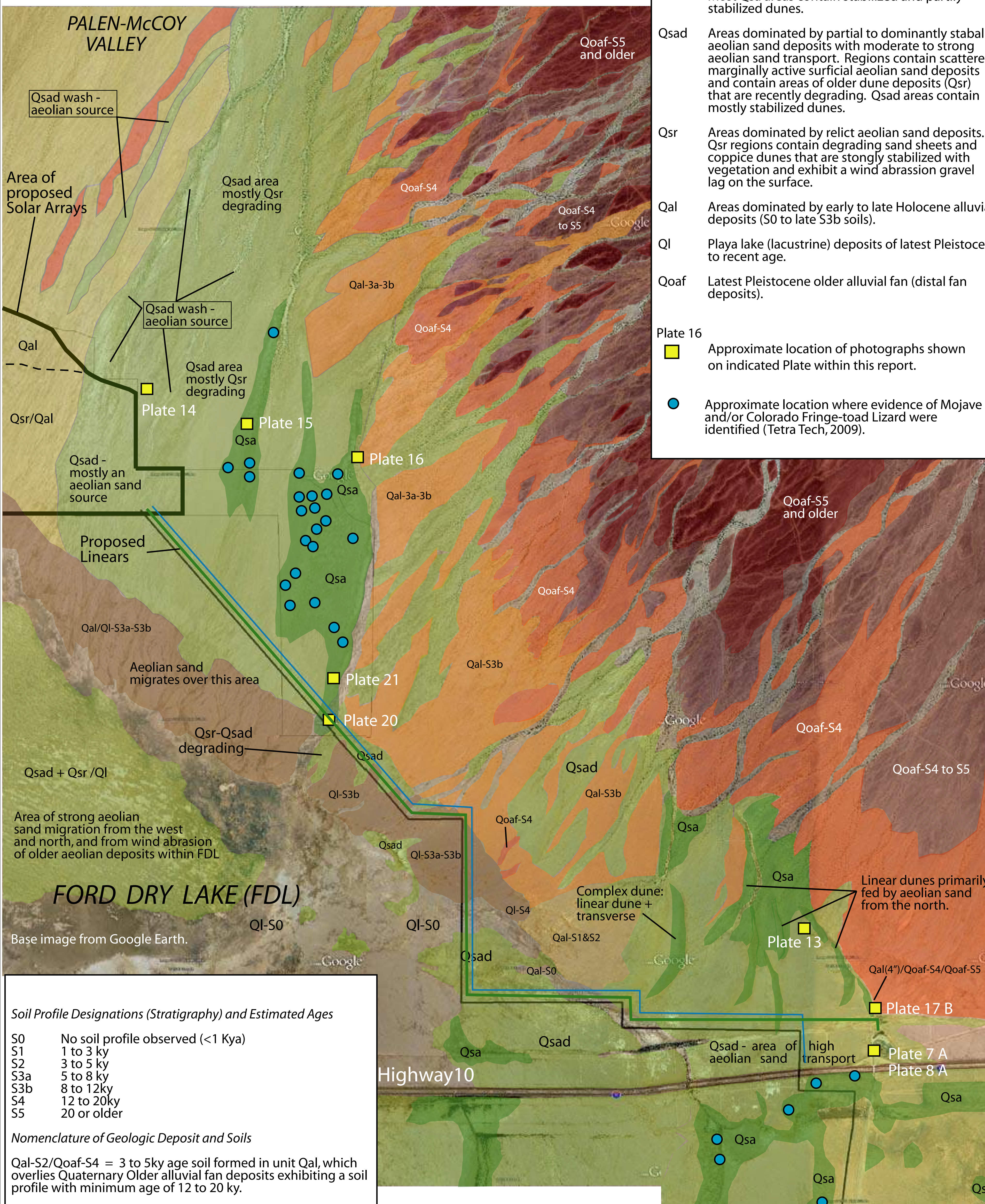
Symbol Descriptions

Geoloogic Units (See Plate 2 and text for full descriptions)

Qw	Late Holocence active wash deposits (not mapped)
Qsa	Areas dominated by active aeolian sand deposits exhibiting loose surficial sand, active sand transport. Most Qsa areas contain stabilized and partly-stabilized dunes.
Qsad	Areas dominated by partial to dominantly stabalized aeolian sand deposits with moderate to strong aeolian sand transport. Regions contain scattered marginally active surficial aeolian sand deposits and contain areas of older dune deposits (Qsr) that are recently degrading. Qsad areas contain mostly stabilized dunes.
Qsr	Areas dominated by relict aeolian sand deposits. Qsr regions contain degrading sand sheets and coppice dunes that are stongly stabilized with vegetation and exhibit a wind abrassion gravel lag on the surface.
Qal	Areas dominated by early to late Holocene alluvial deposits (S0 to late S3b soils).
Ql	Playa lake (lacustrine) deposits of latest Pleistocene to recent age.
Qoaf	Latest Pleistocene older alluvial fan (distal fan deposits).

Plate 16 — Approximate location of photographs shown on indicated Plate within this report.

● Approximate location where evidence of Mojave and/or Colorado Fringe-toad Lizard were identified (Tetra Tech, 2009).



Soil Profile Designations (Stratigraphy) and Estimated Ages

S0	No soil profile observed (<1 Kya)
S1	1 to 3 ky
S2	3 to 5 ky
S3a	5 to 8 ky
S3b	8 to 12ky
S4	12 to 20ky
S5	20 or older

Nomenclature of Geologic Deposit and Soils

Qal-S2/Qoaf-S4 = 3 to 5ky age soil formed in unit Qal, which overlies Quaternary Older alluvial fan deposits exhibiting a soil profile with minimum age of 12 to 20 ky.

N

0 5400'

SCALE (FEET)

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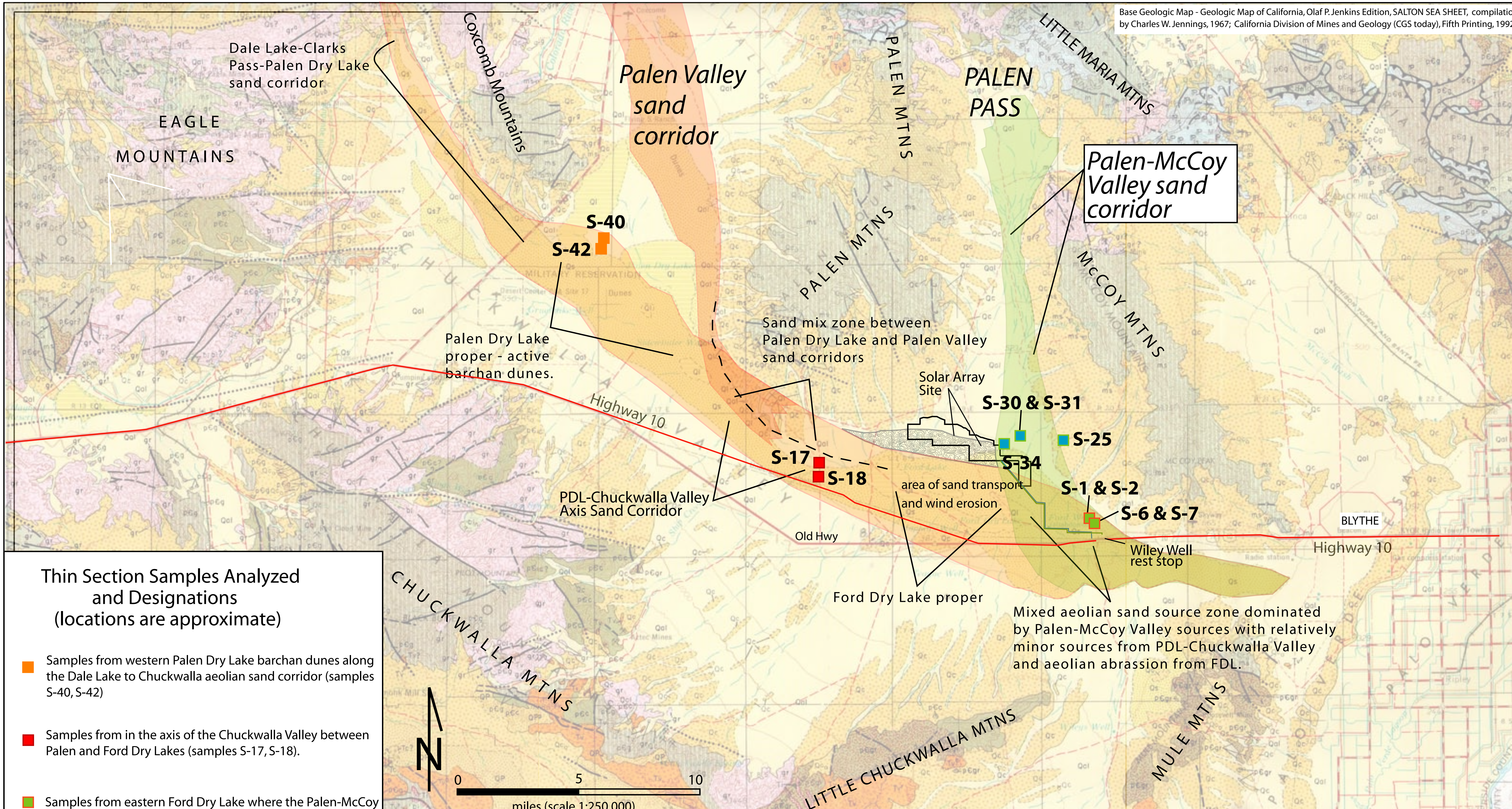
Geologic map of proposed eastern Solar Array and Linears with emphasis on aeolian sand deposits - Genesis Solar Energy Project, Chuckwalla Valley, California.

MK	MT	2/2010
52011206	PLATE 3	



Thin Section Samples Analyzed and Designations (locations are approximate)

- Samples from western Palen Dry Lake barchan dunes along the Dale Lake to Chuckwalla aeolian sand corridor (samples S-40, S-42)
- Samples from in the axis of the Chuckwalla Valley between Palen and Ford Dry Lakes (samples S-17, S-18).
- Samples from eastern Ford Dry Lake where the Palen-McCoy Valley and Palen Dry Lake-Chuckwallay Valley aeolian sand Corridors mix east end of the Project Linears (Samples S-1, S-2, S-6 and S-7).
- Samples from the Palen-McCoy Valley aeolian sand corridor east of the proposed Genesis Solar Power Project (samples S-25, S-30, S-31, S-34).

Approximate current limits of the active wind sand transport corridor from the Palan Dry Lake region down the Chuckwalla Valley. Dominant resultant sand movement toward the east.

Approximate current limits of the active wind sand transport corridor from the Palen Pass region down the Palen and McCoy Mountain Valley. Dominant resultant sand movement toward the south-southeast.

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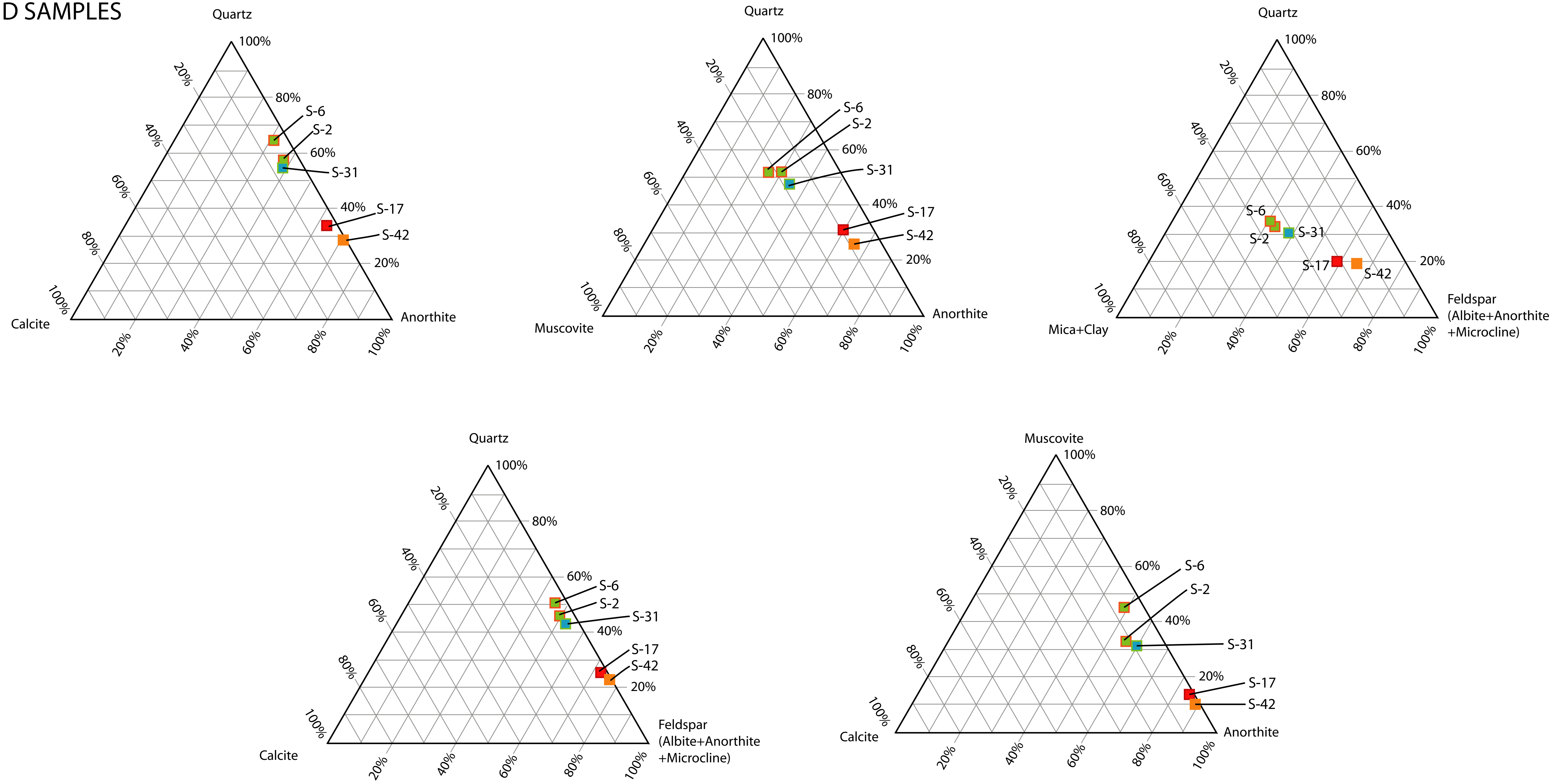
THIN SECTION SAMPLE LOCATION MAP
GENESIS SOLAR ENERGY POWER PROJECT
CHUCKWALLA VALLEY REGION, CALIFORNIA

MK	MT	2/2010
52011206		Plate 4a

MOST ACTIVE SAND SAMPLES



Original data from Applied Petrographic Services, Inc.
XRD Analysis Report dated January 8, 2010 (Appendix B).

- Samples from western Palen Dry Lake barchan dunes along the Dale Lake to Chuckwalla aeolian sand corridor (sample S-42)
- Samples from in the axis of the Chuckwalla Valley between Palen and Ford Dry Lakes (sample S-17).
- Samples from eastern Ford Dry Lake where the Palen-McCoy Valley and Palen Dry Lake-Chuckwalla Valley aeolian sand Corridors mix east end of the Project Linears (Samples S-2 and S-6).
- Samples from the Palen-McCoy Valley aeolian sand corridor east of the proposed Genesis Solar Power Project (sample S-31).

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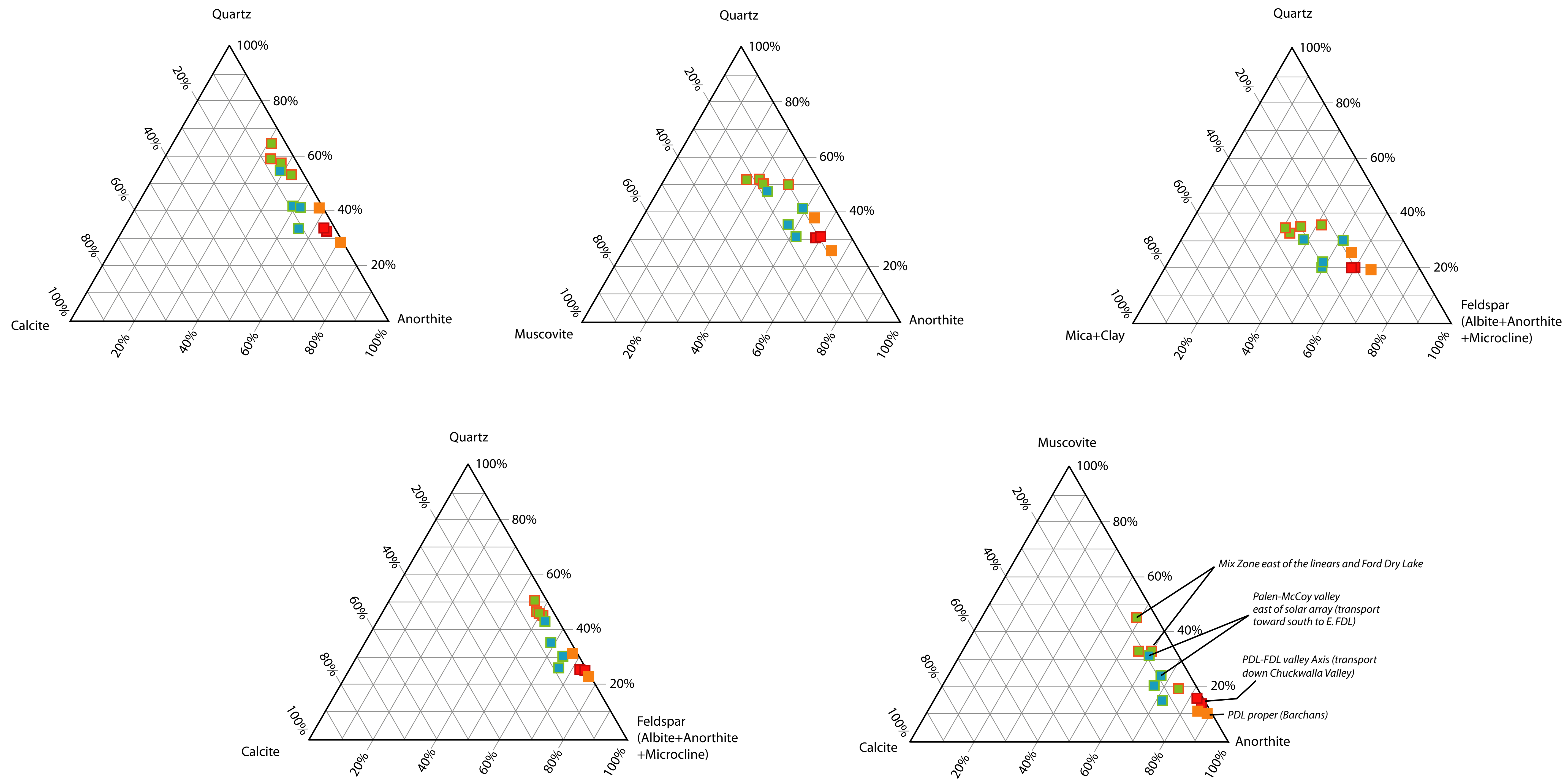
TERNARY COMPOSITIONAL DIAGRAMS FOR MOST ACTIVELY TRANSPORTING AEOLIAN THIN SECTION SAND SAMPLES
GENESIS SOLAR ENERGY PROJECT, CALIFORNIA

MK	MT	2/2010
52011206	Plate 4b	

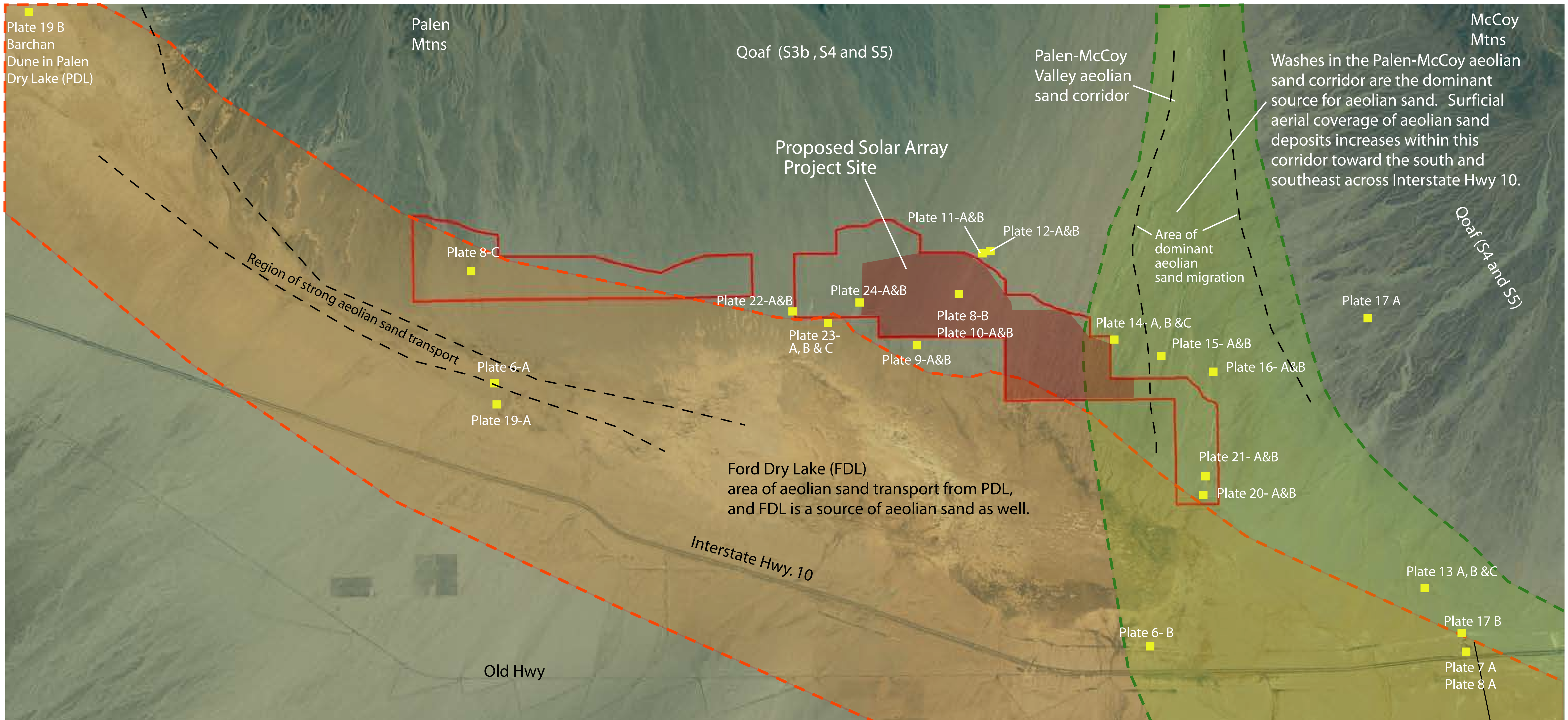
ALL SAND SAMPLES



Original data from Applied Petrographic Services, Inc. XRD Analysis Report dated January 8, 2010 (Appendix C).

- Samples from western Palen Dry Lake barchan dunes along the Dale Lake to Chuckwalla aeolian sand corridor (sample S-40, S-42)
- Samples from in the axis of the Chuckwalla Valley between Palen and Ford Dry Lakes (samples S-17 and S-18).
- Samples from eastern Ford Dry Lake where the Palen-McCoy Valley and Palen Dry Lake-Chuckwalla Valley aeolian sand Corridors mix east end of the Project Linears (samples S-1, S-2, S-6 and S-7).
- Samples from the Palen-McCoy Valley aeolian sand corridor east of the proposed Genesis Solar Power Project (samples S-25, S-30, S-31 and S-32).

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
TERNARY COMPOSITIONAL DIAGRAMS FOR ALL THIN SECTION SAMPLES	MK	MT	2/2010
GENESIS SOLAR ENERGY PROJECT, CALIFORNIA	52011206	Plate 4c	



Base Map: UTM Zone 11, NAD 1983 Projection. Source data: ESRI, USDA

0 Scale (miles) 5

N

Wiley Well
rest stop

Plate 24-A&B — Approximate location of photographs shown on Plates 6 through 24. Individual photographs on plates are listed by capital letter.

Approximate current limits of the active wind sand transport corridor from the Palan Dry Lake region down the Chuckwalla Valley. Dominant resultant sand movement toward the east.

Approximate current limits of the active wind sand transport corridor from the Palen Pass region down the Palen and McCoy Mountain Valley. Dominant resultant sand movement toward the south-southeast.

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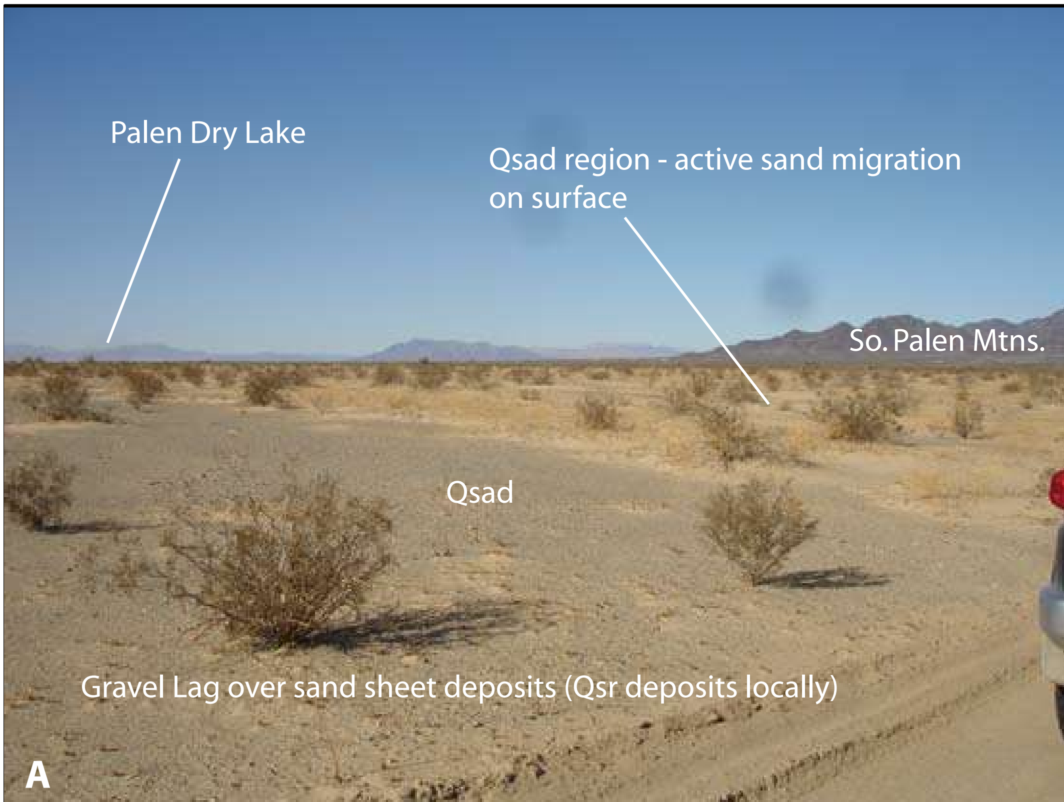
PHOTOGRAPH LOCATION MAP FOR PLATES 6 THROUGH 24,
GENESIS SOLAR ENERGY PROJECT
CHUCKWALLA VALLEY REGION, CALIFORNIA

MK	MT	2/2010
52011206	Plate 5	



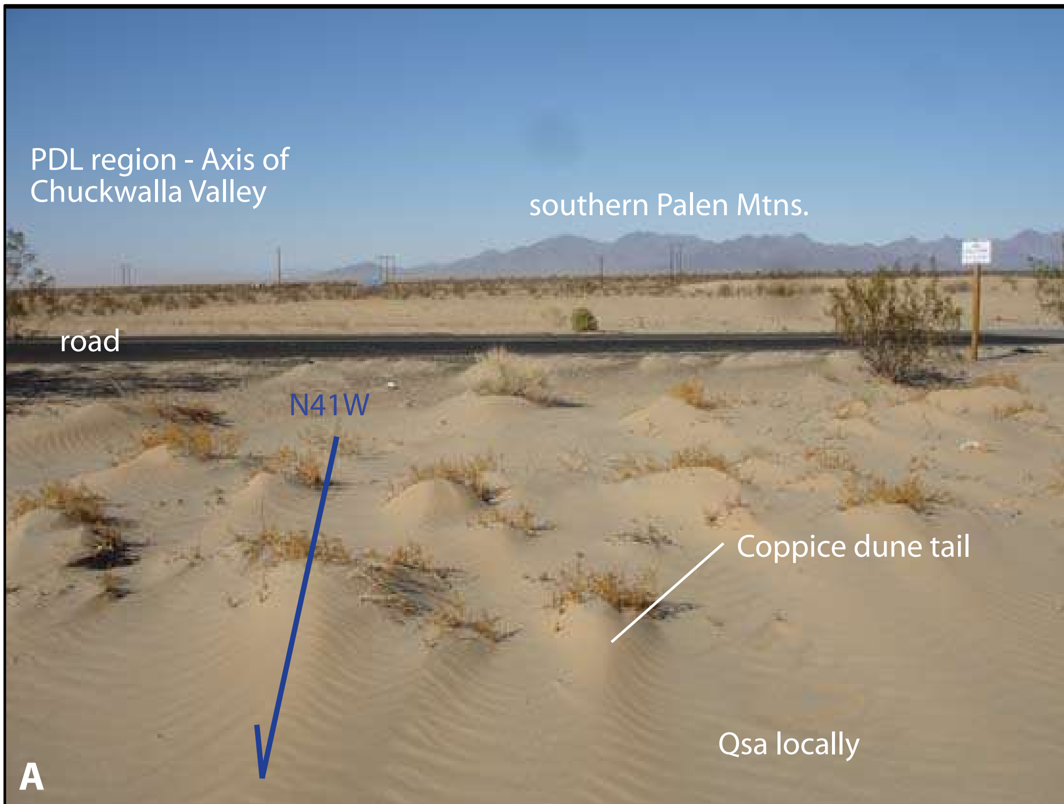
33 39.424
115 05.964
View to the northwest toward Palen Dry Lake (PDL)

Axis of Chuckwalla Valley between Ford Dry Lake (FDL) and PDL - Active sand transport zone from PDL region.

33 36.573
114 57.943
View to the west north-west toward PDL along power line frontage road.

Active barchan dune migrating over the road fed by sand moving from the Palen-McCoy Valley direction and over FDL. Dust cloud in distance moving toward the east to south east from PDL region and passing to the south of this site.

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 6	



33 36.564
114 54.079
WILEY WELL REST STOP

Active Coppice Dunes with "Tails"

Coppice dune tails provide strong wind direction vectors. Here the view is into the wind from N41W pointing toward the southern Palen Mtns. This indicates that the winds from PDL are merging with winds from the Palen-McCoy Valley to the right of the picture. In this area recent aeolian sand dominate winds varied from ~N40W to N10W.

Example of typical strongly degraded coppice dune at base of creosote. Numerous burrows, grasses, eroded, and vegetation debris. These are common in Qsr and Qsad mapped regions. Local stablized dune.

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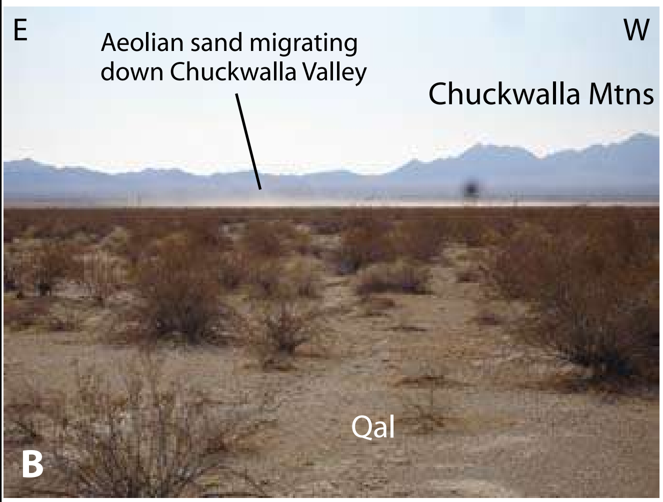
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 7	

AEOLIAN SAND MIGRATION OBSERVED IN THE FIELD

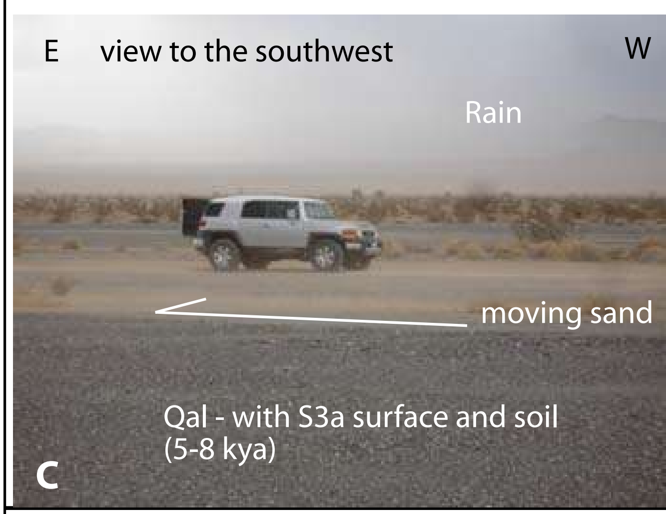
33 36.564
114 54.079
WILEY WELL REST STOP ACCESS ROAD

Aeolian sand moving across the road on December 23, 2009. Sand moving from wind blowing from N41W. Active sand ripples in foreground.



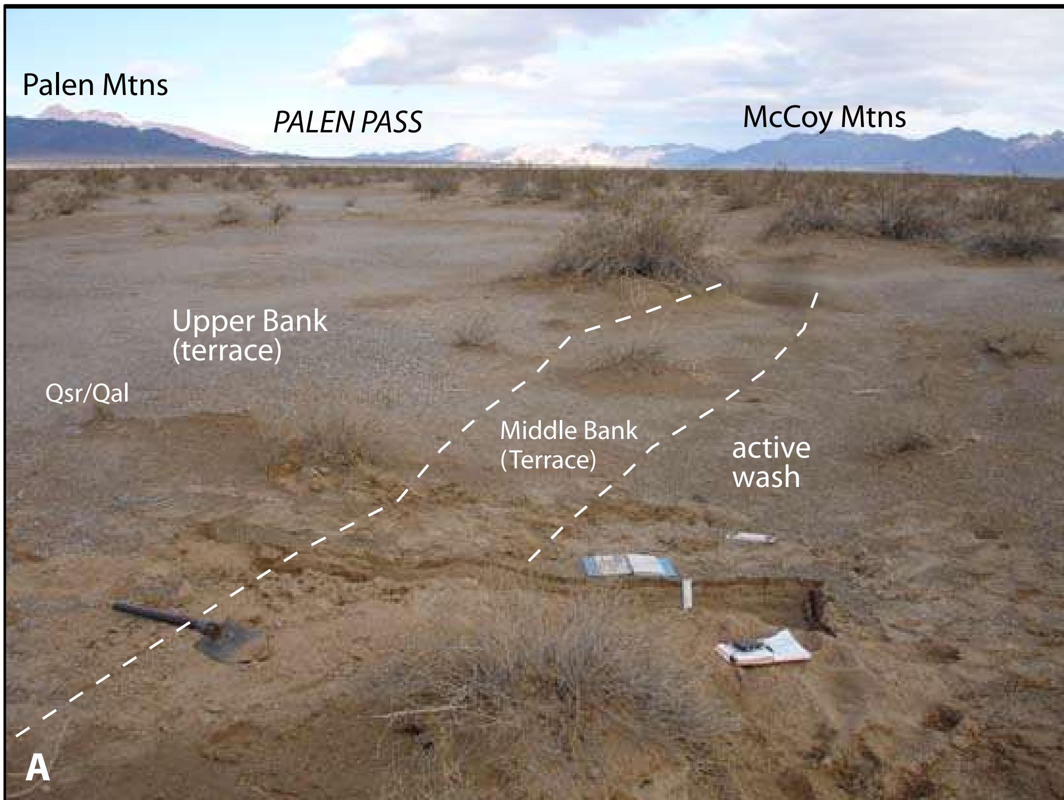
33 40.268
115 00.225
Site located near the center of the proposed western solar array. View to the south on December 22, 2009 and can observe that no aeolian sand is migrating within property, aeolian sand is migrating toward the east down the Chuckwalla Valley and over the southern side of FDL.

Local test pit geology at this site is Qal-S0(4.5")/Qal-S3a(8.5")/Qoa-S4. Also note lack of relict-degraded coppice dunes, thus area mapped as Qal.



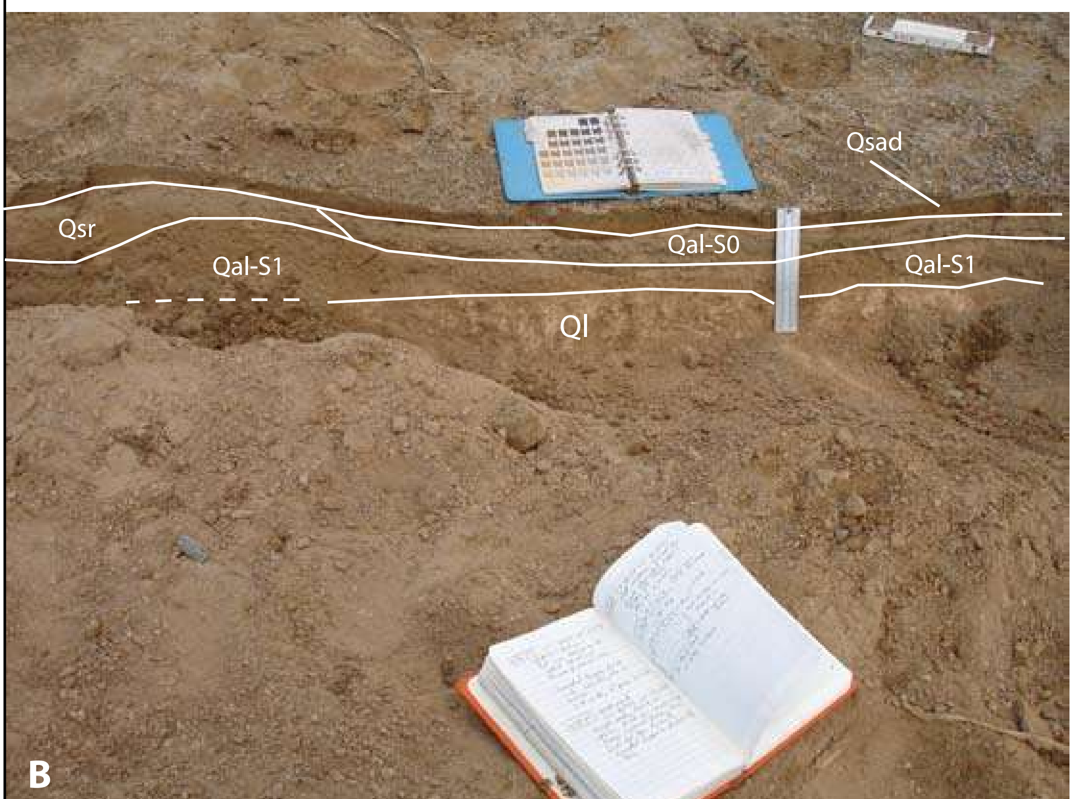
33 40.580
115 06.264
Site located on north-south dirt road that transects the Chuckwalla Valley between PDL and FDL near northern boundary of the PDL-Chuckwalla Valley sand migration corridor (Plate 1). Here aeolian sand is actively moving from wind blowing from N46W with occassional rain as can be seen in the upper right of photo (observed on December 22, 2009).

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 8	



33 39.740
115 00.750 Elev. 375' msl
Site located ~900 feet south of western solar array PL. View to the north toward Palen Pass.

Typical wash with 4" to 6" bed and bank relief. Wash has not flowed recently. ~3" Qsr deposited on banks and 1/4" of Qs within wash overlying Qw and Qal. See test pit photo below. Area mapped as Qsr. Notice degraded coppice dunes within wash. Area of minor sand migration.



Test Pit Photo with interpretation. Blue book and ruler are in the same location as shown in above photograph and photo view toward the north.

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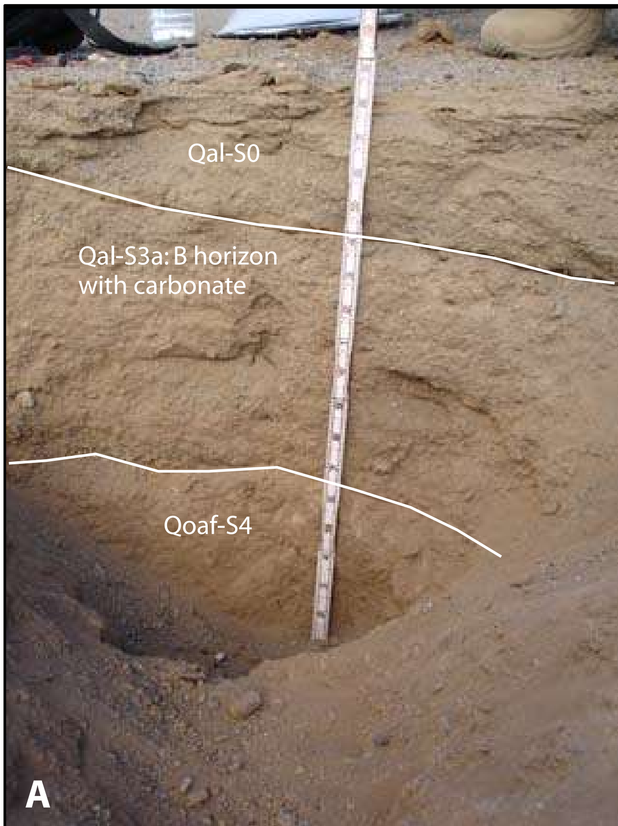
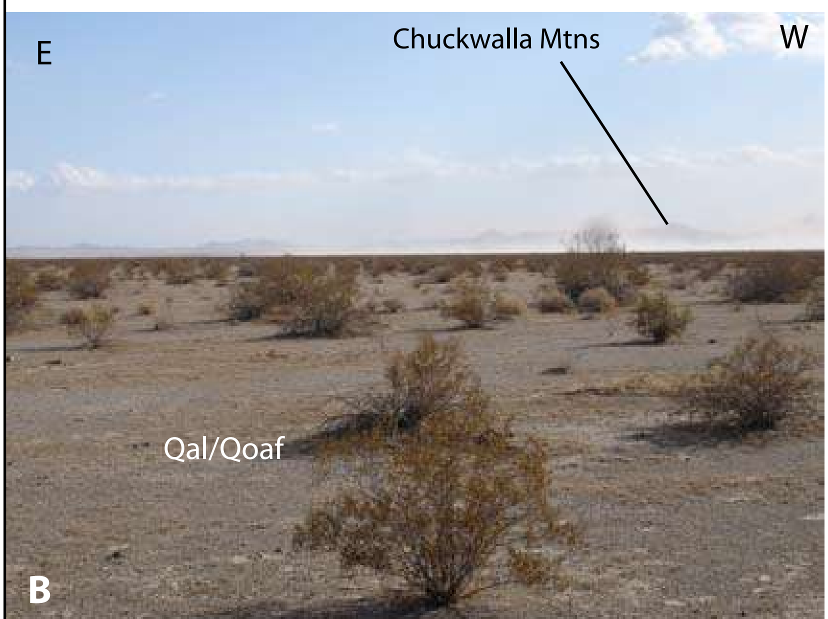
PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 9	



33 40.268
115 00.225 Elevation 388'
Test pit located within central region of western proposed solar array. Photograph below is of same location showing the landscape.

Geologic unit designations are shown and indicate the area is underlain by 4.5" of Qal-S0/8.5" Qal-S3a (7-8kya)/Qoaf-S4 (minimum 12 kya).



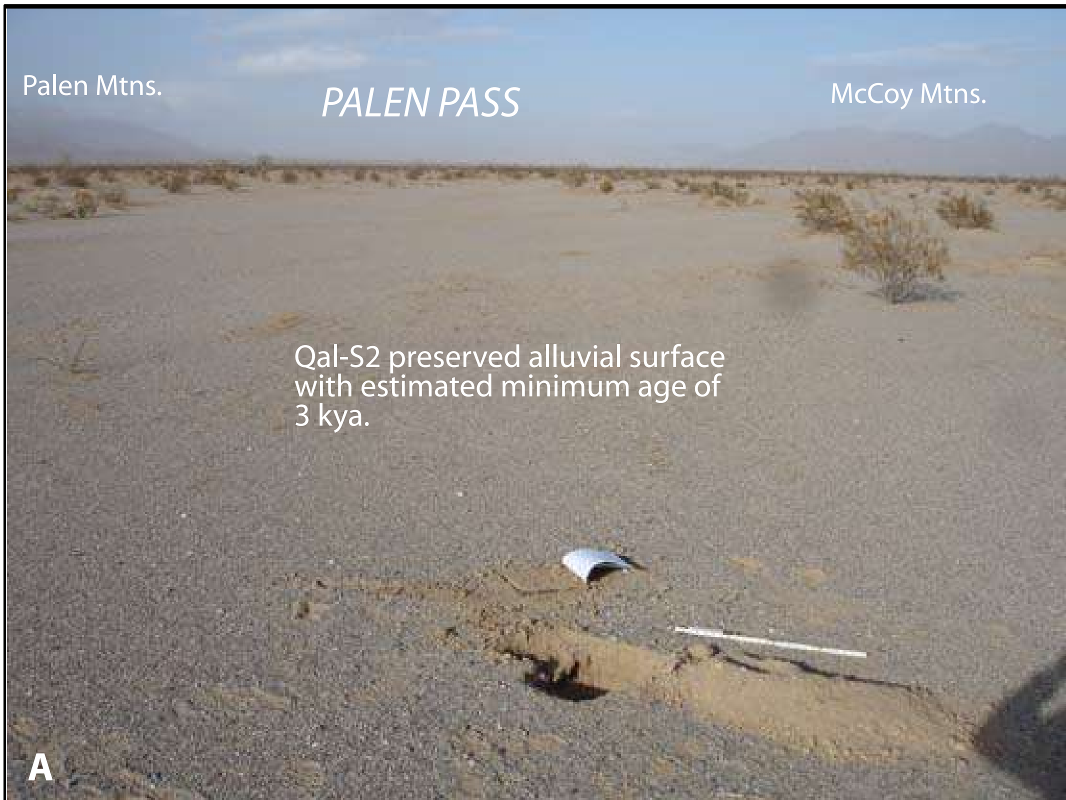
33 40.268
115 00.225 Elevation 388'

View toward the southeast on December 22, 2009.

Photo shows lack of degraded coppice dunes and wind abrasion gravel lag.

Notice strong winds pushing dust (silt and clay) up into the air hundreds of feet as sand is transported down the Chuckwalla Valley over the central and southern portions of FDL.

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 10	



33 40.689
114 59.913 Elev. 402' msl

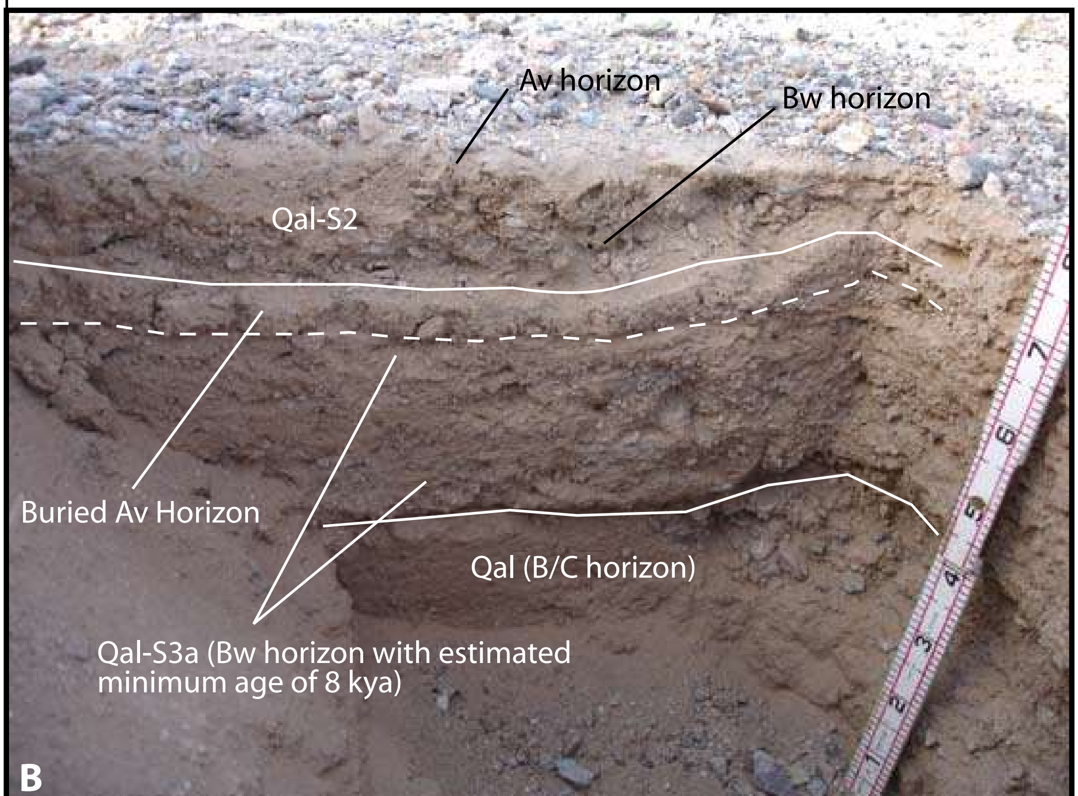
Site located ~430' northeast of northern property line for proposed western solar array.

View toward the north at Palen Pass.

Qal-S2 surface in foreground.

Test Pit shown in more detail below.

Region mapped as Qal. Notice lack of coppice dunes or any other evidence of aeolian sand migration or deposition.



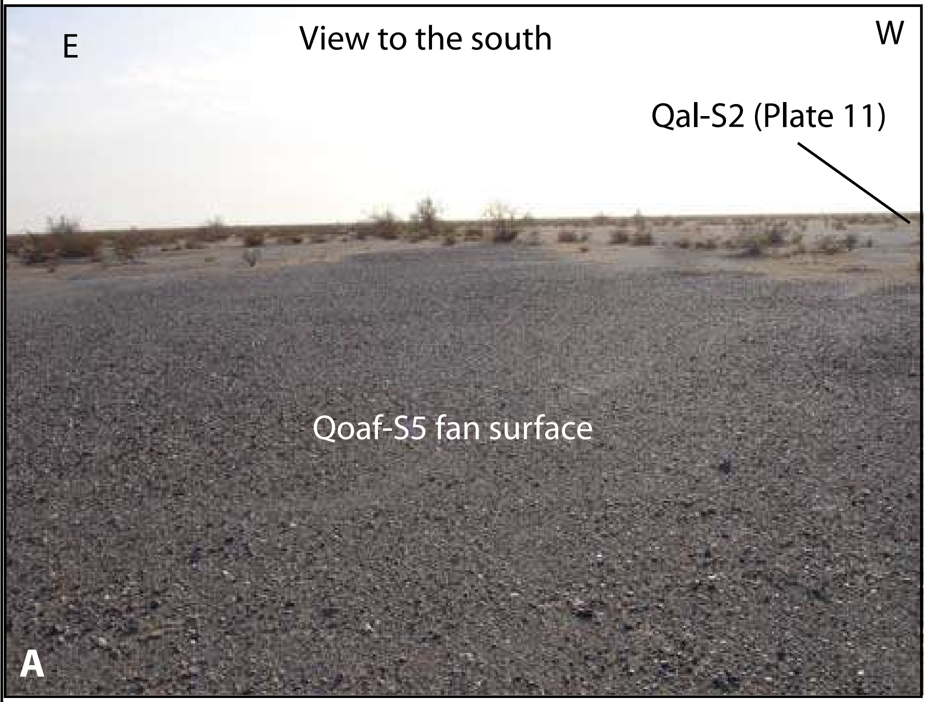
33 40.689
114 59.913 Elev. 402' msl

Test pit photo with unit interpretation.

Note lack of any aeolian sand deposits within test pit.

GENESIS SOLAR, LLC	WorleyParsons resources & energy		
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 11	

QOAF DEPOSITS WITH PRESERVED FAN SURFACE IN PROPOSED WESTERN SOLAR ARRAY

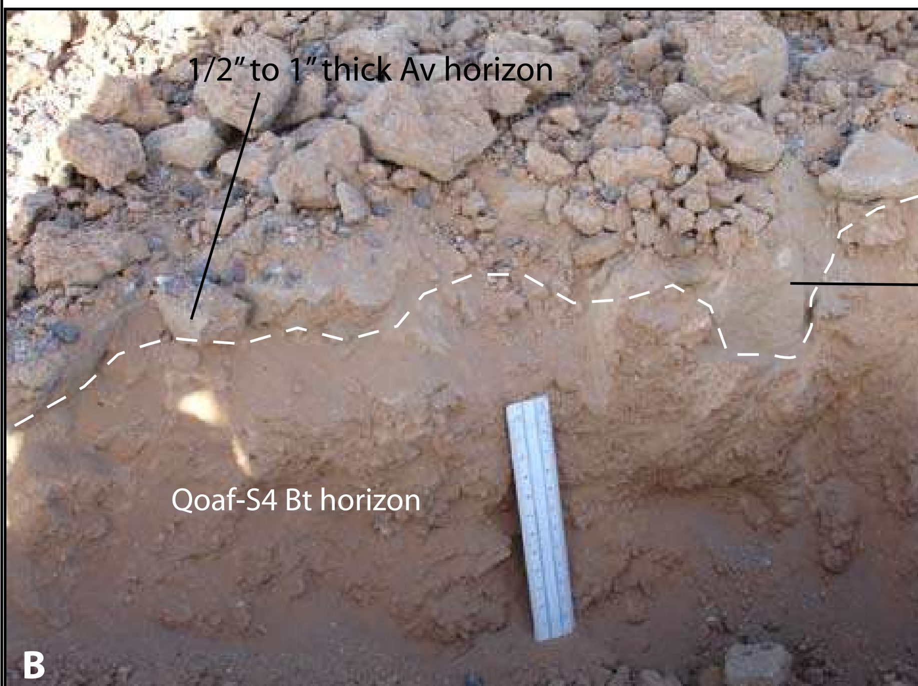


33 40.696
114 59.872 Elevation 402' msl.

This site is located just a couple hundred feet from photos shown on Plate 11.

Qoaf-S4 preserved alluvial fan surface. Estimated age 12 to 20 kya. This unit extends into the northern portion of the proposed solar array and is common within 1 to 2 feet of the surface across most of the proposed solar array property above elevation 377' msl.

Test pit shown in photo below is near the photographers feet of photograph A.



Test pit with interpretation of typical Qoaf-S4. Ruler is approximately 6-inches long.

Av material filling vertical joints in Bt

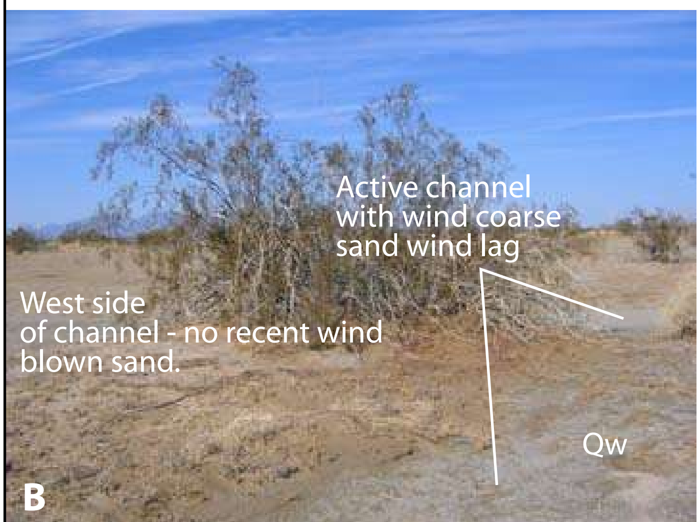
GENESIS SOLAR, LLC	WorleyParsons resources & energy		
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 12	

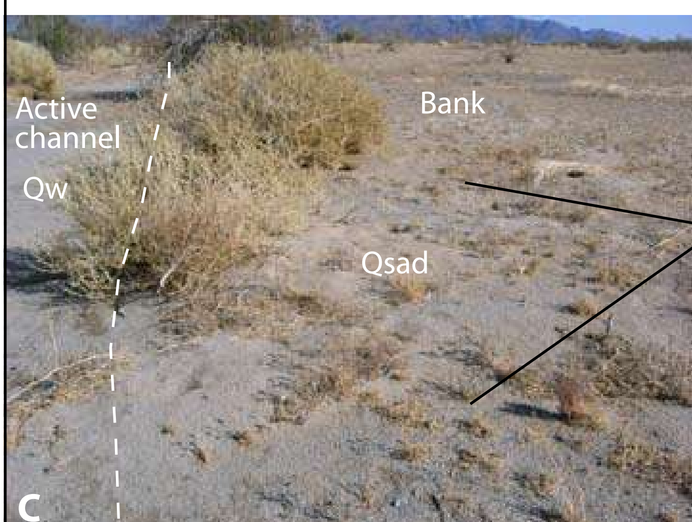
EASTERN FORD DRY LAKE REGION - LOCAL WASHES A MINOR SOURCE FOR AEOLIAN SAND

33 37.255
114 54.557 Elevation 402'

Site located in eastern Ford Dry Lake basin north-northwest of the Wiley Well Rest Stop approximately 5000 feet. Area within aeolian sand migrating corridor dominated by the Palen-McCloy Valley sand corridor but also from the PDL-Chuckwalla Valley sand corridor to a lesser extent.

This photo shows active channels that are eroding into older alluvial and sand sheet deposits and producing new sources of aeolian sand. See photos below at same location.





East side of channel - Abundant medium to coarse aeolian sand blown out of the active channel toward the southeast

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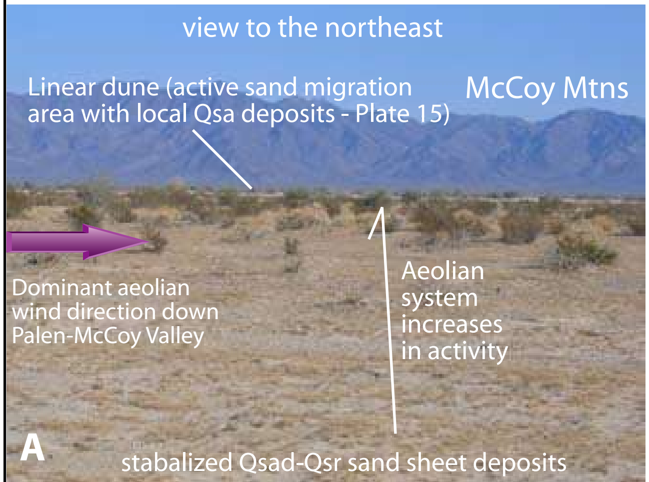
PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 13	

These photos demonstrate a gradual decrease in the magnitude of sand transport and deposition within Qsad toward the west just east of the northeastern property line for the proposed eastern solar array.



33 39.775
114 58.284 Elevation 396'

Site located ~440' east of proposed eastern solar array within mapped Qsad region. View toward the northeast with McCoy Mtns in the background.

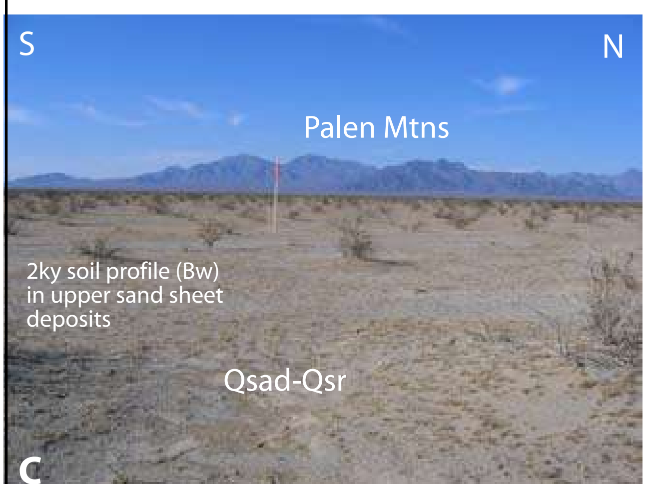
Photo shows stabalized sand sheets with hummocky dune terrain that is poorly drained and contains numerous internal depressions. Aeolian sand migrates over this area dominantly toward the south-southeast toward Wiley Well rest stop. The crest of a linear dune can be seen along the horizon of the desert floor.

33 39.812
114 58.354 Elevation 396'

Site located ~110' east of proposed eastern solar array within mapped Qsad region.

Photo view is toward the dominant wind from Palen Pass comes from (~N10W) controlling aeolian sand migration. This area experiences some sand transport toward the southeast but very minor net deposit.

Test pit here exhibited Qsr-S1(5")/Qal. Qsr represents stabalized sand sheets with ~2 kya Bw soil horizon.



33 39.812
114 58.354 Elevation 396' Same site as above photo. View toward property line stake with location.
33 39.833, 114 58.393.

Same geologic conditions as described in above photo. Notice the local depression within stabalized Qsad deposits, lack of coppice dunes (active of degraded).

Provided evidence indicates that this area experiences minor sand transport and very minor net sand deposition during the past 2 ky.

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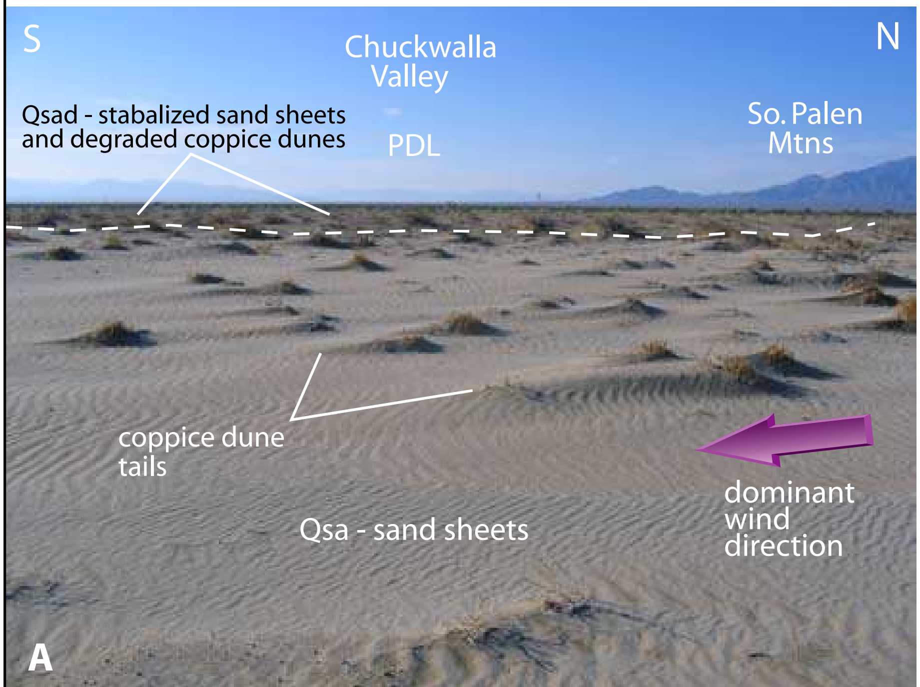
PHOTOGRAPHS	MK	MT	2/2010	
	52011206	PLATE 14		

EASTERN PALEN-McCOY VALLEY AEOLIAN SAND CORRIDOR - INCREASE IN AEOLIAN SAND MIGRATION AND DEPOSITION TOWARD THE EAST FROM PHOTOS ON PLATE 16 TO HERE. THE SAND CORRIDOR IS CHARACTERIZED BY ZONES OF ACTIVE AEOLIAN DEPOSITION (BELOW) AND OTHER AREAS OF VERY MINOR NET DEPOSITION IN NORTH-SOUTH BANDS

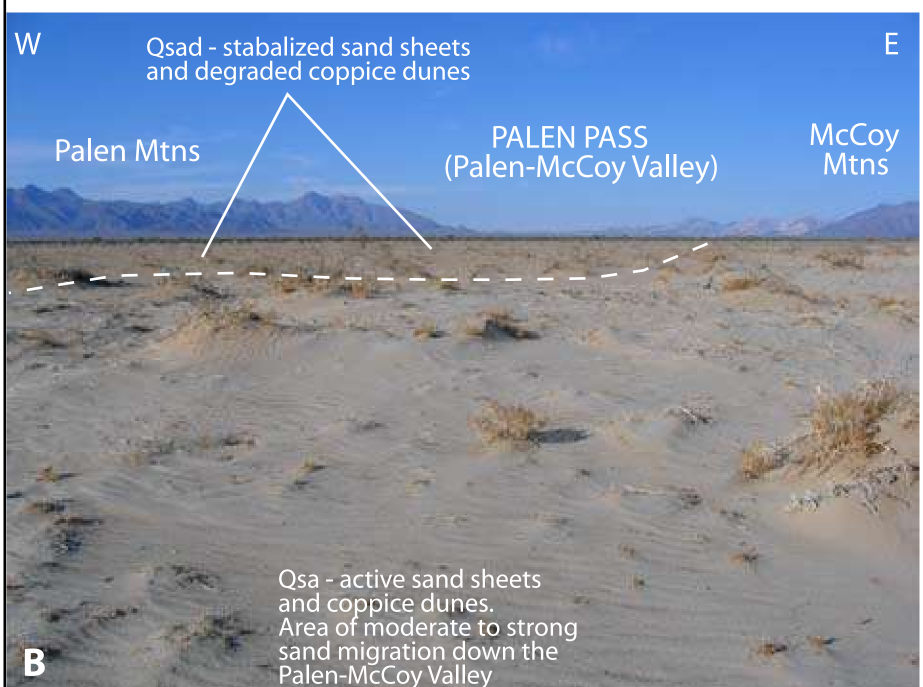


33 39.634
114 57.745 Elev.ation 399' msl

Site is located ~3,000 feet east of eastern property line for proposed solar array. This site is about half way between Plate 15 location and the linear dune shown in the background on Plate 14 photo.

This image looks toward the west in the area of PDL, the southern Palen Mountains, Chuckwalla Valley, and toward the last site shown at property line stake 33 39.833; 114 58.393 (Plate 14).

Photo exhibits Qsa deposits of sand sheets (migrating sand ripples) and active coppice dunes and tails. Tails indicated dominant wind from the north (right side of picture). This is Mojave Fringe Toad Lizard habitat.



Same location as above picture but looking toward Palen Pass at the north end of the Palen-McCoy Valley. Aeolian sand source comes from active washes up gradient and dominant northern winds push the sand toward the southeast along the eastern side of Palen-McCoy valley.

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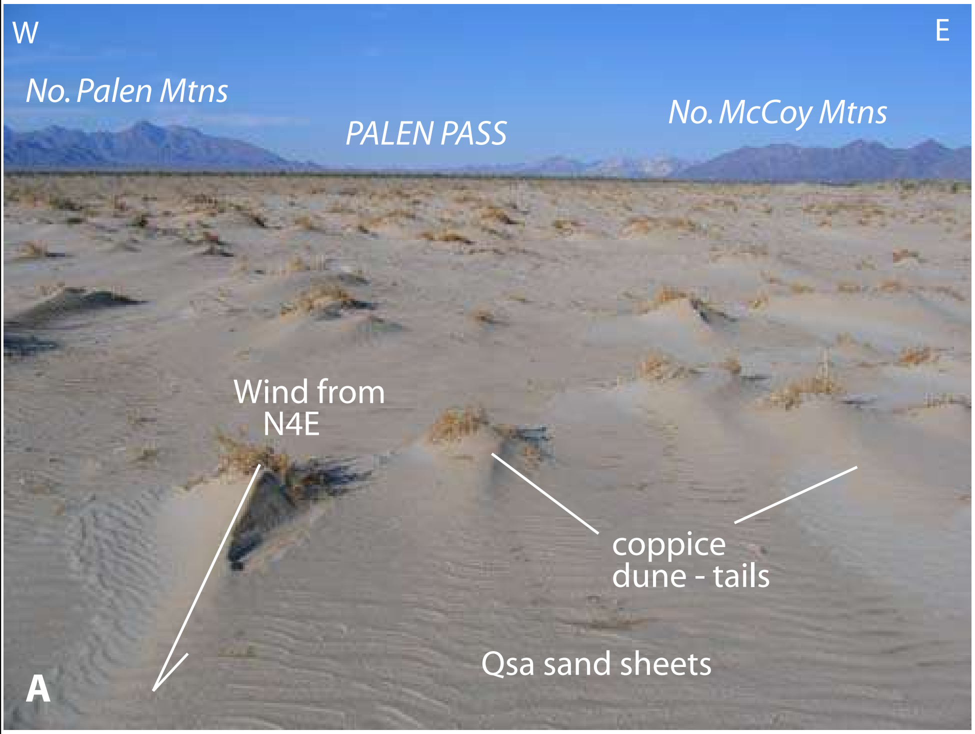
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 15	

THE PALEN-McCOY VALLEY AEOLIAN SAND CORRIDOR



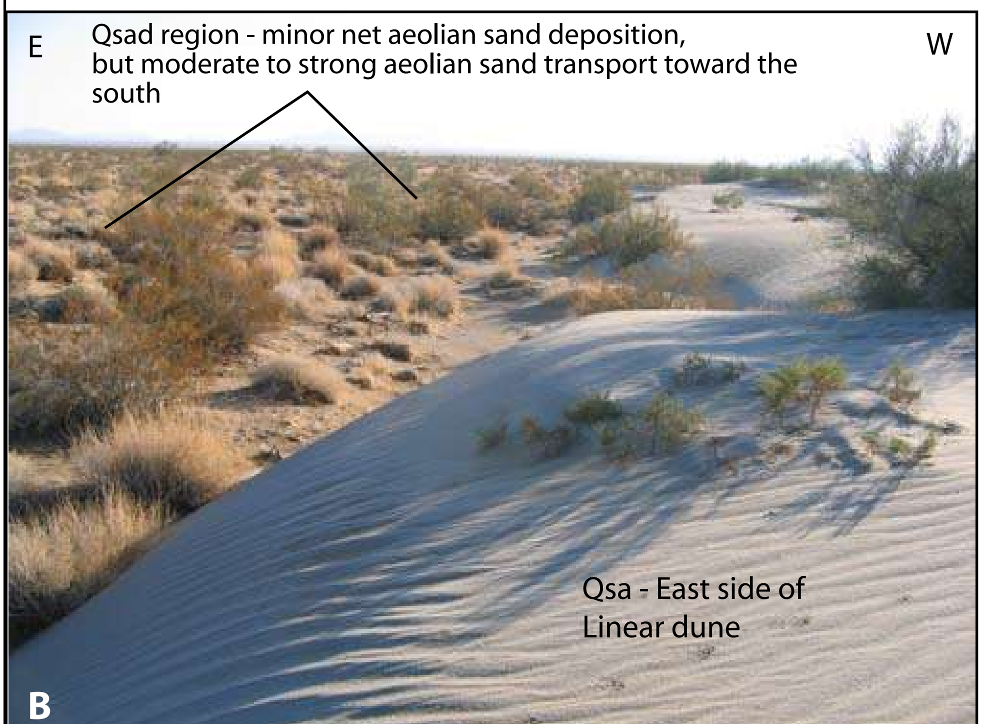
33 39.478
114 57.130 Elevation 409' msl

Site east of Plate 15 site by ~3,000 feet.

Photo view toward the north-northwest (N10W to N4E) from the eastern Palen-McCoy Valley up to Palen Pass.

Area of unit Qsa exhibiting strong active sand transport: Coppice dunes with tails, migrating ripples depositing sand sheets, active linear dune.

The linear dune shown below is just 50 feet to the right of photo. Notice the lack of vegetation on the western side of the dune shown here.



Just 50 feet east of above photo location.

The view is toward the south-southeast in the direction of Wiley Well rest stop.

Photo exhibits the eastern side of an active linear dune. This is the leeward side with active avalanche face.

Dune migrates over time in the direction of view.

Notice the increased vegetation on the eastern side of the dune possibly due to the linear dune not having passed over this area yet.

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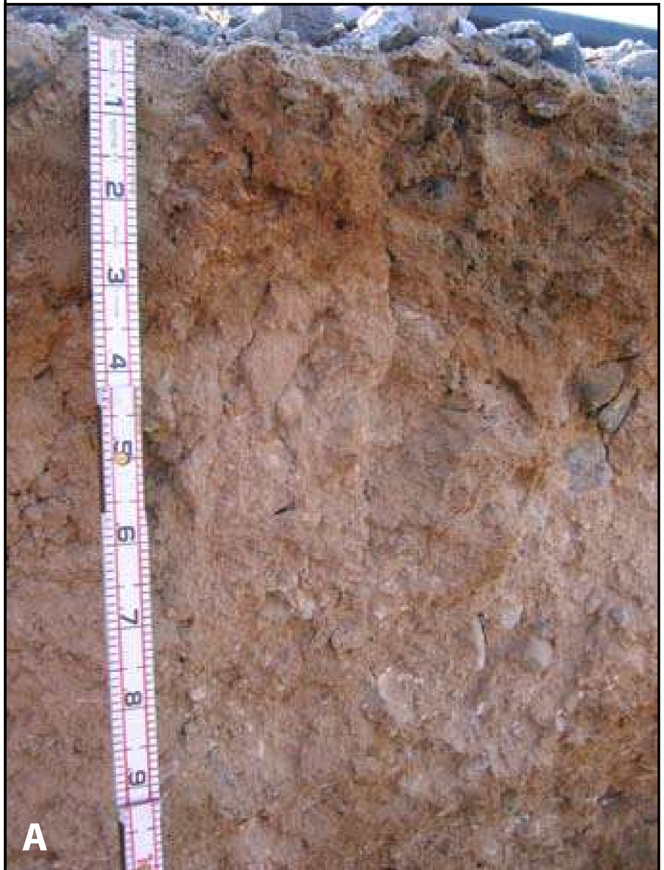
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 16	

EXAMPLES OF S4 AND S5 DESIGNATED SOIL PROFILES
DEVELOPED IN UNIT QOAF



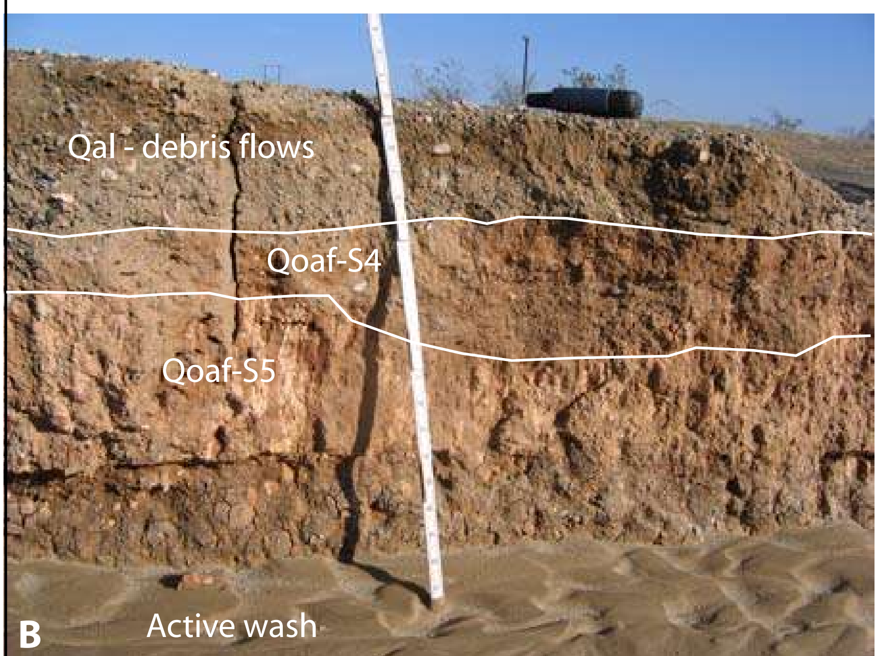
33 40.008
114 55.242 Elevation 499' msl.

Exposure of typical latest Pleistocene soil S4 developed in unit Qoaf. Minimum estimated age is 12 to 20 ky (see text).

Unit exhibits strong yellowish red hues, secondary clay, strong structure, medium dense to dense, and carbonate stringers to small concretions.

Unit lacks larger carbonate concretions identified in soil S5 shown below.

The Qoaf-S4 preserved fan surface (terrace) resides only 1.5' below the elevation of the Qoaf-S5 fan surface locally.



33 36.742
114 54.087 Elevation 396'

Site just a few hundred feet north of Wiley Well rest stop.

Photo shows a channel that flowed during the early December, 2009 typical major winter storm. This type of channel, once it flows, becomes a source for aeolian sand.

Geologically, the photograph shows Qal deposits overlying Qoaf-S4, which overlies Qoaf-S5 soils. Interpretation indicated on photograph. Qoaf-S5 has 1/4" to 3/4" inch wide carbonate vertical zones, and is a minimum of 20 to 45 kya.

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PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 17	

Qoaf-S4 AND S5 FAN SURFACES AND CLAST RUBIFICATION

Qoaf-S4 preserved fan surface. These surfaces exhibit moderately strong to strong packing desert pavement, moderate to strong desert varnish, moderate to strong rubification, and degraded bar and swale (see photo below).

This site is located approximately 2 miles east of the proposed solar array where Qoaf-S4 and S5 fan surfaces are well exposed. These units underly most of the Project site within the upper 1 to 3 feet.

Qoa-S4 fan surface showing moderate to strong rubification at base of clasts, and moderately strong tostrong packing. Ruler is approximately 6 inches long.

Qoaf-S5 fan surface demonstrating tight desert pavement packfing, strong desert varnish.

Qoaf-S5 fan surface degraded. Overturned clast demonstrates strong rubification (redding) that increases in strength over time. This magnitude of rubification stongly suggests that the fan surface is a minimum of latest Pleistocene in age.

Note: The locations of these photographs are not shown on Plate 6 as they represent generalized characteristics of unit Qoa.

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PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 18	

LUCASTRINE DEPOSITS (UNIT QL)

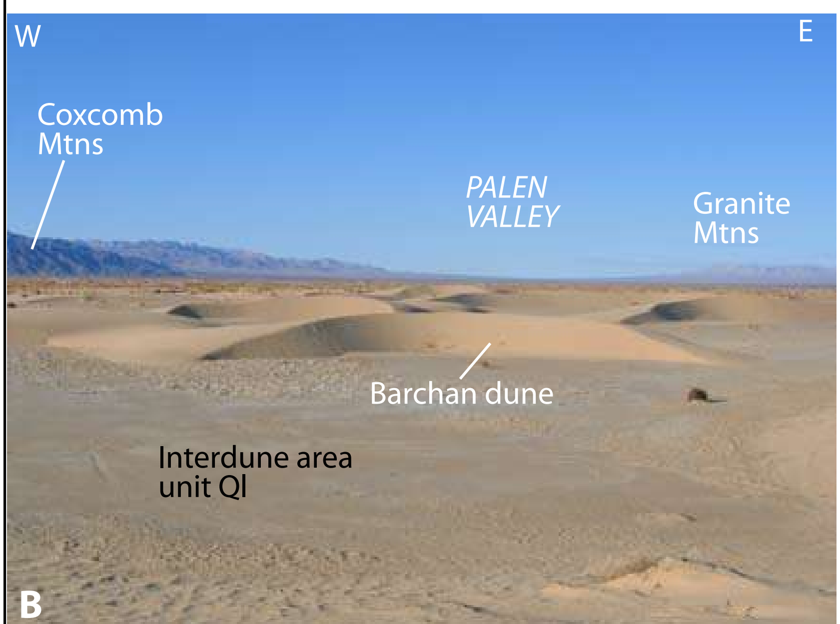
33 39.208
115 05.964 Elevation 378' msl.

Site located on north-south dirt road at the western end of FDL and east of PDL. This area is within the PDL-Chuckwalla Valley sand migration corridor.

Photo shows a test pit excavated into lacustrine deposits (unit Ql). Pit exposes a weak soil profile (S1) consisting of a thin (1/4" thick) Av horizon overlying a Bw (2" thick).

Ql deposits are composed of sandy silt, medium dense, and crudely bedded to massive. Texture appears to exhibit remnants of desication cracks associated with drying if ephemeral playa lakes.

PALEN DRY LAKE - ACTIVE AEOLIAN DUNE SYSTEM



33 43.299
115 11.744 Elevation 424' msl.

Site located in the eastern portion of the PDL active dune field.

Photo exhibits a view up the Palen Valley with the Coxcomb Mountains in the west and the Granite mountains in the distance (right side of photo).

Photo shows a series of active barchan dunes some of which interconnect to begin formation of transverse dunes. Ql deposits associated with PDL are shown within the interdune areas.

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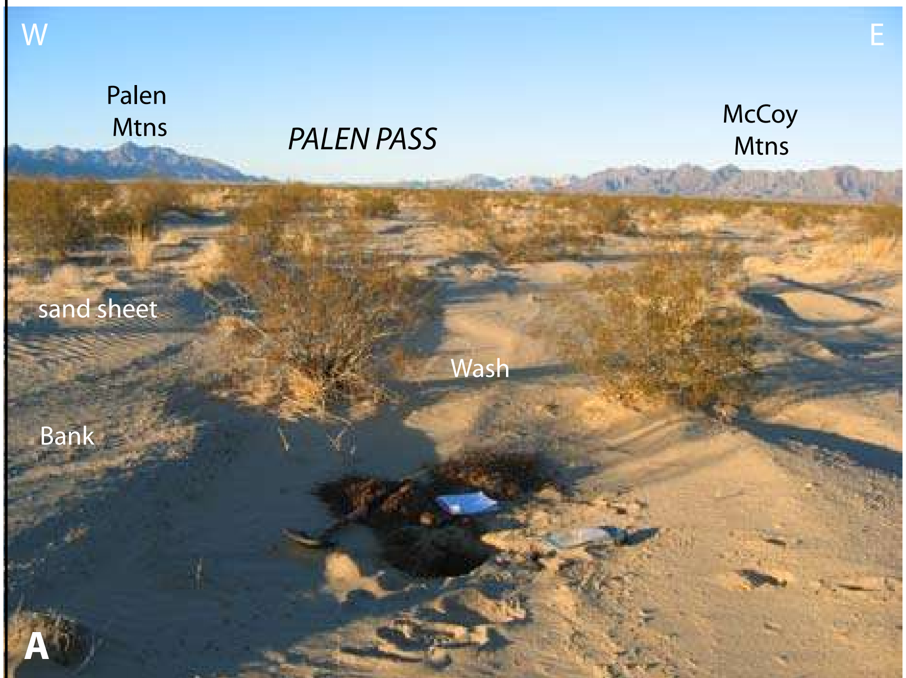
PHOTOGRAPHS	MK	MT	2/2010	
	52011206	PLATE 19		

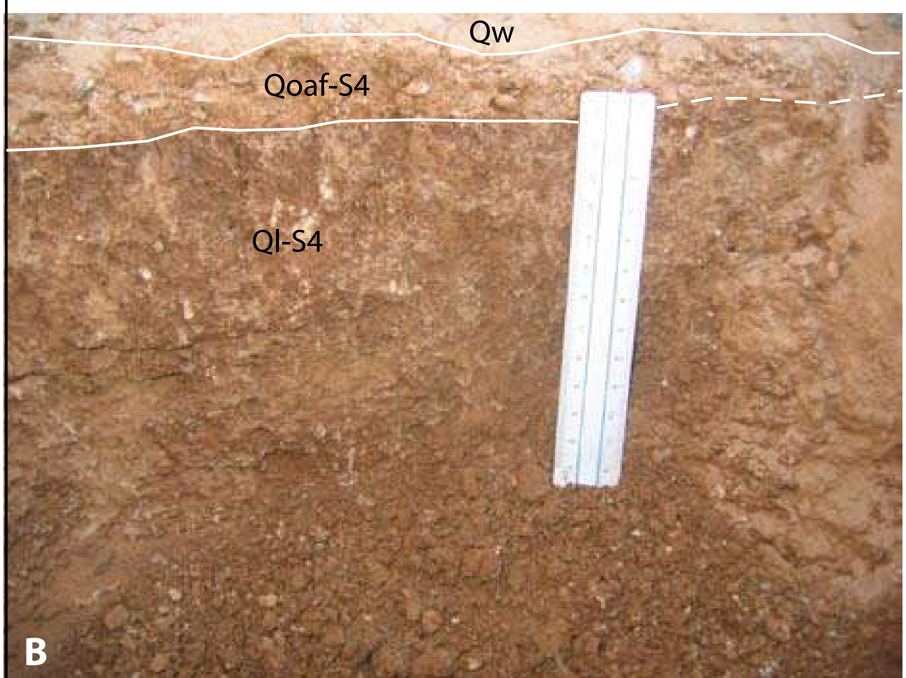
LACUSTRINE DEPOSITS AND ACTIVE WASH LOCATED NORTH OF NORTHWESTERN END OF LINEARS



33 38.210
114 57.251 Elevation 372' msl.

Photo looking toward Palen Pass with the Palen Mtns (left side) and McCoy Mtns (right side). This area is within the Palen-McCoy Valley active aeolian sand migration corridor. Area dominated by aeolian sand migratiion from Palen Pass, and minor sand input from the PDL region. Area exhibits minor net aeolian sand deposition.

Photo within active channel but filled with thin aeolian sand deposits along the banks. Active channel deposits (Qw) only 3 to4 inches thick overlies a 2 to3 inch thick layer of Older Alluvial fan deposit Qoaf that overlies lacustrine deposits (Ql). See test pit below. Area bounding channel is borderline Qsa to Qsad.



Test pit shown in above photograph with interpretation.

Qw(2 to 3")/Qoaf-S4(2")/Ql-S4

Note: Within the channel, approximately 1 to 2 inches of recent aeolian sand deposits exist overlying unit Qw.

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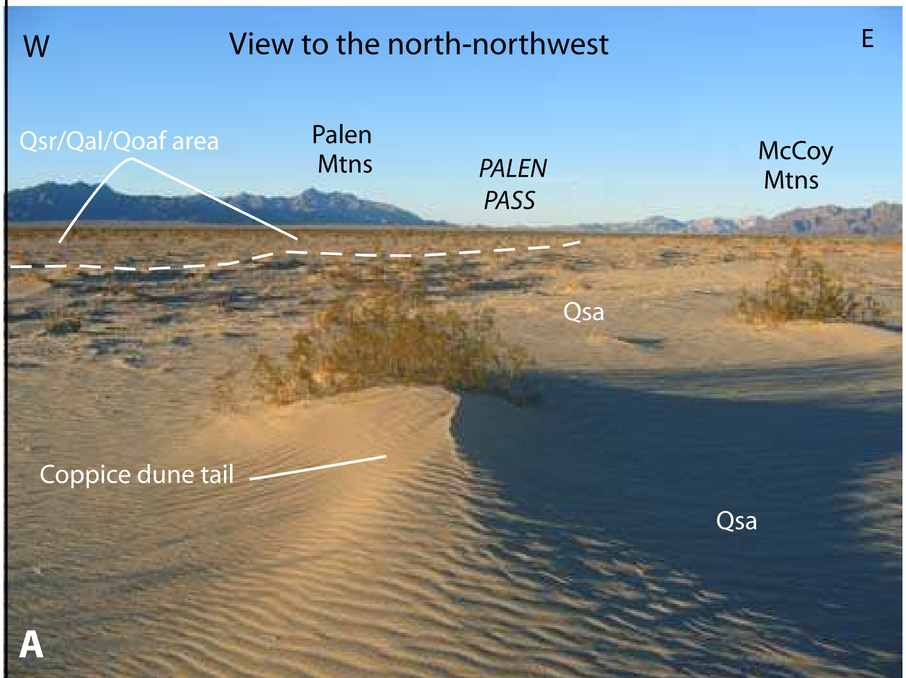
PHOTOGRAPHS

MK	MT	2/2010	
52011206	PLATE 20		

PALEN-MCCOY VALLEY AEOLIAN SAND MIGRATION CORRIDOR -
EAST OF SOLAR ARRAYS AND NORTH OF NORTHWESTERN LINEARS



33 38.416
114 57.232 Elevation 377′ msl.

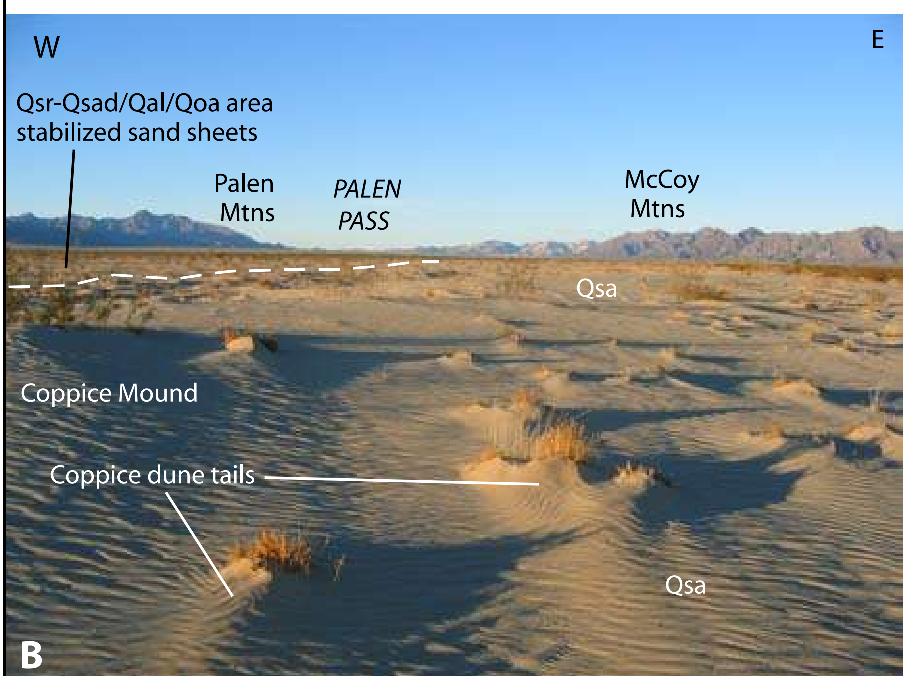
Site located within area of active aeolian deposition near the southern end of an active linear dune.

Photo view toward Palen Pass to the north and along the Palen-McCoy Valley aeolian sand migration corridor.

Well developed and maintained active coppice dune with associated dune tail shown.

Ripples indicated high level of recent aeolian sand migration activity. Both ripples and coppice dune tails indicated dominant aeolian sand migration wind eminate from Palen Pass.

Limits of active loose aeolian sand deposition (Qsa) and dominantly inactive area with no recent aeolian deposition shown in the background.



Same location and view direction as above photograph.

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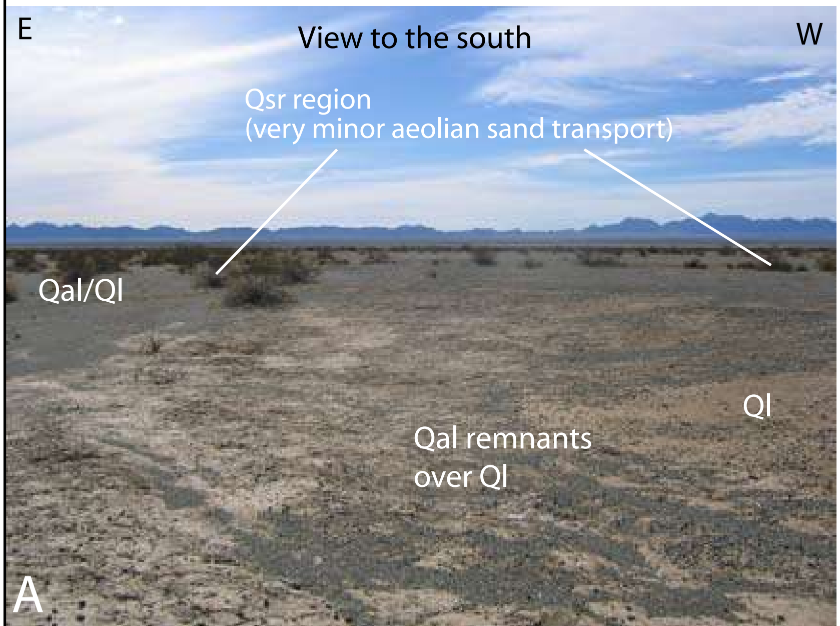
PHOTOGRAPHS	MK	MT	2/2010
	52011206	PLATE 21	



33 40.128
115 02.310 Elevation 372' msl

Site located just west of the western solar arrays. View is toward the south and the Chuckwalla Mountains.

Photo shows lacustrine (Ql) deposits in the forground with thin remnants of alluvium (Qal) on it's surface.

Bounding the relatively higher Ql deposits is a region exhibiting Qal over Ql.
Area exhibits Qsr degraded coppice dunes

Same location as above photo but view to the north-northwest toward the Palen Mtns.

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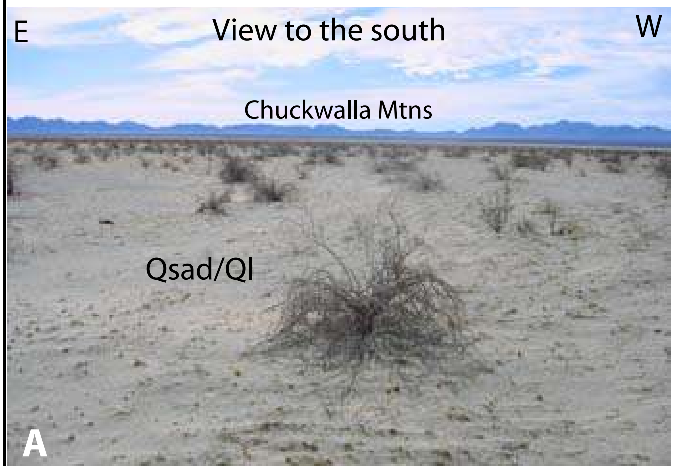
PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 22	

AREA OF ACTIVE AEOLIAN SAND TRASPORT - JUST SOUTH OF SOUTHWESTERN SOLAR ARRAY



33 40.001
115 01.875 Elevation 371' msl.

This photo shows an area of minor sand transport and minor net aeolian deposition just south of the proposed western solar array. The sand is mostly coarse grained sand and is migrating as ripples across the surface. Lacustrine depostions (Ql) typical reside just below the thin layer of aeolian sand.

Photograph of the ground near above site that shows thin layer of migrating sand. Notice the degrading coppice dune.

This area represents a marginal aeolian dune system that is fed some wind blown sand from nearby washes, from the PDL-Chuckwalla sand corridor, and from Ford Dry Lake (FDL).

Same location as photograph A above but view is toward the northeast.

This is the northern area of the active aeolian sand transport toward the southeast. Just a few hundred feet north of this site exhibits relict thin sand sheet deposits (Qsr) near the southern property line of the proposed solar array.

The Biological Resources Technical Report (August, 2009) mapped this area as Playa and Sand Drifts over Playa. This was substantiated by this report as well. The BRTR (8/2009) did not identify any MFTL in this area (see their Figure 10).

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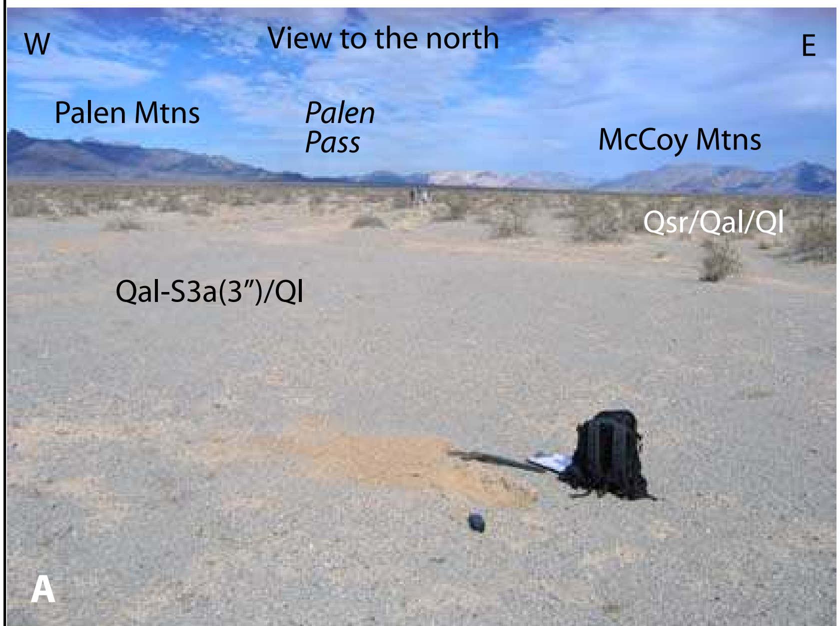
PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 23	

SOUTHWEST CORNER OF PROPOSED SOLAR ARRAY



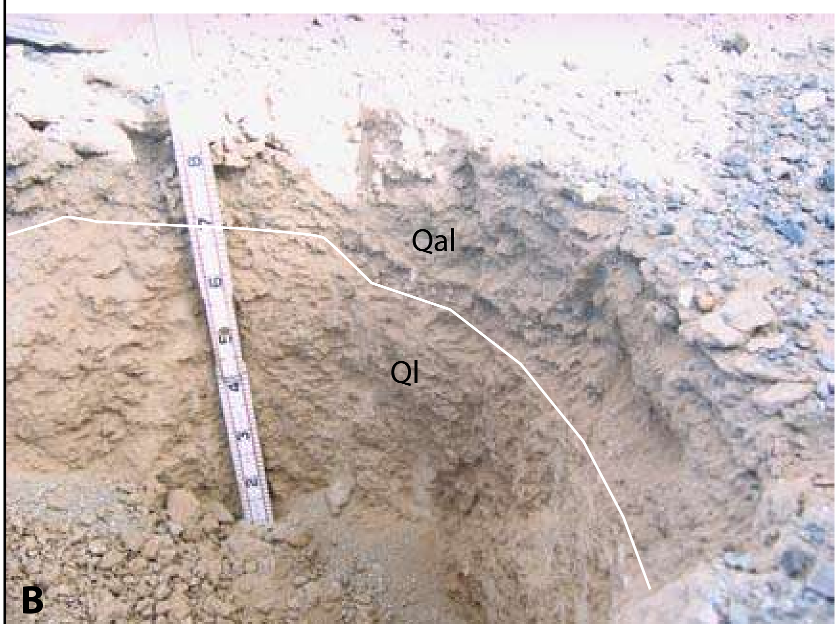
33 40.204
115 01.482 Elevation 376' msl.

The view in this photograph is toward the north and Palen Pass.

The image shows a nonvegetated area consisting of a thin layer of alluvium (Qal) over lacustrine deposits (Ql). These exposures are common in the southwestern portion of the site, particularly below elevation ~377 to 380' msl.

Surrounding area exhibits similar geologic stratigraphy with the exception of remants of degraded thin sand sheets mapped as Qsr.

Unit Qal exhibits a S3a soil to possibly late S3b soil indicating a minimum geomorphic surface age of 5 to 9 ky.



Photograph of test pit shown in above image.

Geologic Interpretation:

0- 0.25": Av horizon (pink, 7.5YR 7/3)
0.25-3.0": Bw horizon within Qal parent material. Exhibits secondary silt/clay lamellae, carbonate cementation, light brown (7.5YR 6/4).
3.0 - 9.0": Bw horizon within Ql parent material. Stage I carbonate stringers.

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PHOTOGRAPHS

MK	MT	2/2010
52011206	PLATE 24	

APPENDIX A
INTERIM ANCIENT LAKE SHORELINE REPORT DATED JANUARY 19, 2010.

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February 5, 2010
52011206

Genesis Solar LLC
700 Universe Blvd.
Juno Beach, FL 33408

Attn: Mike Pappalardo, Environmental Manager

Re: Report of Ancient Shorelines in Ford Dry Lake for Genesis Solar Energy Project, Chuckwalla Valley, Riverside County, CA

Dear Mr. Pappalardo:

This letter report provides findings regarding temporal and spatial behavior of ancient playa lakes in the Ford Dry Lake basin located in the eastern portion of the Chuckwalla Valley. The study focused on the timing and high stand elevations of playa lakes with emphasis on the proposed Genesis Solar Power Project site. This report was requested by members of the CEC during a conference call Work Shop on December 31 to assist Cultural aspects of the Genesis Solar Energy Project (Project).

Methodology

The results of this report discussed below are based on review of existing literature, site field mapping, evaluation of numerically dated desert soils from the eastern Coachella Valley (Petra, 2007a and 2007b), analysis of orthophotographs, and utilization of Google Earth images.

Literature Review

Literature reviewed is provided in the reference section of this report, and addresses primarily studies of regional timing of latest Pleistocene to Holocene playa and pluvial lake systems.

Mapping Program

A week of field mapping in the Chuckwalla Valley included the project site and surrounding area. Data was obtained to evaluate the limits and age of ancient lake shore lines between the elevations of approximately 360’ to 380’ above mean sea level (msl). Shallow test pits to 1.5 feet provided an assessment of sediment types and soil profile development (age of sediments).

Numerically Dated Desert Soils from the Coachella Valley

Previous large scale fault investigations covering more than 6000 acres within the eastern Coachella Valley (Petra, 2007a, 2007b) were overseen by the author. These studies were located 80 miles due west of the Genesis project site within Coachella Fan alluvial deposits shed from the Little San Bernardino Mountains. As part of the latter studies, numerous soil profiles were evaluated on a morphostratigraphic series of late Pleistocene to Holocene age preserved fan surfaces. The soils within fan deposits represent a chronosequence or a group of soil variables such as topography, parent material, vegetation, and climate that are roughly equal (Jenny, 1941). These soil descriptions and ages were utilized to provide minimum preliminary soil profile ages within this study. This is discussed further in following sections.

Orthophotographic Mapping
High resolution color orthophotographs were examined to identify geomorphic features that may be associated with ancient lake shore lines.

Google Earth
Google Earth is an internet program that provides detailed photographic images of the surface of the Earth with scale and location. Latitude, longitude and elevation are overlain on the maps. Google Earth was used to identify geomorphic features possibly associated with ancient shore lines (wave cut benches, beach berms or deposits, etc) and produce the base map in Plate 1. The accuracy of shore line elevations is dependant on that provided by Google Earth in the area of the investigation.

SEDIMENT DATING TECHNIQUES

The age of the site geologic units was determined in both numerical and relative terms. Relative ages were assigned by stratigraphic position of the sedimentary layers. In alluvial fan environments, morphostratigraphic relationships may also provide relative ages for fan deposits. In upper fan reaches the older preserved fan surfaces (terraces) are generally at higher elevations than younger surfaces. In distal areas of the fan, older deposits are typically buried by the younger layers. Numerical ages for sedimentary units may be assigned by careful examination of the soil profiles. For this study, numerical ages for sediments were arrived at by correlating site soil profiles with known dated soils in the Coachella Valley (Petra, 2007a and 2007b).

Soil Profile and Geomorphic Surface Development Ages
Soil profiles provide **minimum** dates for sedimentary units. This process estimates the minimum age of the sedimentary units based on the degree of soil profile (pedon) development at the uppermost portion of the unit and for buried soil profiles within the unit. Of primary importance is that soil profiles do not provide the age of sediments. Instead, they reflect when deposition ceased and prolonged exposure of the sediments to near-surface weathering processes initiated. A rough deposition age can be arrived at by the sum of cumulative ages of the uppermost soil pedon and all buried pedons within the unit(s). Desert soils are typically dated utilizing the Soil Development Index (SDI) method of Harding (1982). With an SDI value, a soil in question may be compared to other regional soils evaluated with the same method and dated with absolute techniques such as Carbon-14. Empirically, SDI values have shown strong correlations to soil age (Harden, 1982; Rockwell et al., 1985; Reheis et al., 1990;; Rockwell, et al., 1994; and Helms et al., 2003).

Morphostratigraphic Age Correlation
Morphostratigraphic units are the correlation of fill terrace fan deposits (soil age), into the drainages where the same units are buried by younger fan deposits. In theory stratigraphically deeper fan deposits preserved beneath younger sediments in lower elevations may be traced to geomorphically higher positions at the proximal part of the fan system. This correlation is critical because it permits the transfer of numerical soil profile ages determined for the preserved fan surfaces (soil ages) to buried depositional units at lower elevations.

MOJAVE DESERT PLAYA AND PLUVIAL LAKES

One of the geomorphic hallmarks of the Basin and Range Geomorphic Province (BRGP) is that streams terminate in local or regional valley sinks (i.e. Playa or Pluvial lakes) and not the Pacific Ocean or Sea of Cortez (USGS, 1967). With internal drainage, the region is truly a basin. An exception is the Colorado River just east of the site which empties into the Sea of Cortez (Gulf of California). After a long episode of extensional tectonics during the late Tertiary, the elevated ranges eroded rapidly while valleys filled with the resulting sediment. Over time the aerial extent of mountain ranges and valleys have decreased and increased respectively. Today in the late stage of evolution, the ranges are diminished while the wide valleys and extensive alluvial fans dominate the topography.

Many of the BRGP valley sinks contained lakes during the glacial maximums of the Pleistocene (Morrison, 1991; Reheis, 1999; Reheis, 2005; Castiglia and Fawcett, 2006; Reheis et. al., 2007). A distinction can be made between Pluvial and Playa lakes. Pluvial or perennial lakes formed during Pleistocene glacial maximums that existed for thousands of years. Playa lakes are quite ephemeral with life cycles of one to a few tens of years. G.I. Smith (Dohrenwend, 1991) has provided several contrasts between pluvial and playa lake deposits. **Pluvial (perennial) lakes** are inferred where: (1) sediment hues are green, yellow, or olive-brown (5GY, 10Y, or 5Y); (2) clasts are well sorted and their sizes range from clay to medium sand; (3) bedding is distinct, thin, or laminar; (4) aquatic fossils are noted; and/or (5) saline layers are absent. **Playa (ephemeral) lake** deposits are inferred where: (1) sediment hues are orange or brown (10YR, 5YR0; (2) clasts are poorly sorted and their sizes range from silt to sand; (3) bedding is indistinct, massive, or deltaic; (4) aquatic fossils are absent; and/or (5) saline layers are present. Using these criteria and deep boring data within Palen and Ford Dry lakes, Smith (Dohrenwend, 1991) showed that both of these basins bear playa lake deposits to depths of ~160 meters (bottom of borings).

LOCAL SOIL DESIGNATIONS

For this study, a series of soil designations were determined that provide a preliminary soil pedon stratigraphy for the site. The designations are indented to provide a minimum age range for the soils and thus, minimum ages for the time of abandonment of the surface to the near surface soil processes. A detailed soils profile analysis has not yet been conducted at the site, and the designated age ranges are minimum, (conservative) values for the soils identified. The soil designations and estimated age ranges include:

SOIL DESIGNATION	***AGE RANGE AND LIMITED DESCRIPTION***
S0	**<1000 years (1 ky)** No soil development.
S1	**1 to 3 kya** No desert varnish, weak surface gravel packing; 1/8" Av horizon, weak cambic Bw horizon typically to 3" depth (strong brown 7.5YR 5.6 dry), Entisol.
S2	**3 to 5 kya** Weak desert pavement and no to very slight desert varnish, slightly perceptible rubification, 1/16" thick carbonate rings along clast-

	surface contact, slight softening of clast surfaces from wind abrasion, 1/4” to1/2” thick gray to light yellowish brown (10YR 6/4 dry) Av and deepening Cambic Bw horizons (3 to 4 inches), minor secondary minerals, penetrative carbonate, Stage I-, slight hardening of B horizon.
S3a	**5 to 8 kya** Weak to moderately developed desert pavement and varnish, faint but clearly visible rubification, carbonate rings along clast-surface contact, softening of exposed clast surfaces from wind abrasion, ¼” pink (7.5YR 7/3 dry) Av horizon, Reddish Brown (5YR 7/3 dry) Bw horizon in parent fine grained sandy silt deposits to light yellowish brown (10YR 6/4 dry) to light brown (7.5YR 6/4 dry) in gravelly sand parent material, medium dense, blocky, iron oxide staining along vertical joints, Bwk horizon within 8” to 10” of surface, visible stage I- to I carbonate stringers-concentrations.
S3b	**8 - 12 kya** Moderate developed desert pavement, moderate desert varnish, carbonate rings along clast-surface contact, softening of clast edges by wind abrasion, ¼” pink (5YR 7/3 dry) Av horizon, 3” thick reddish yellow (5YR 6/6 dry) Bt with secondary clay, 5” thick light reddish brown (5YR 6/4 dry to damp) blocky Btk horizon with minimum stage I carbonate stringers, and horizontal Bk horizons.
S4	**12 - 20 kya** Moderate to well developed desert varnish and pavement, ¼” to 1 ½” pink (5YR 7/3 dry) Av horizon, Bt horizon: 4 to 8 inches thick, yellowish red (5YR 5/6 dry) thick, numerous vertical joints filled with Av material spaced at 3 to 8 inches and extending 3 to 6 inches deep, medium dense to dense, pinhole porosity, carbonate in upper 3 inches, secondary clay, clay ped bridging with blocky structure from 8 to 13 inch depth, in places Btk horizons as filaments to 1/8 inch diameter concretions in fine grained parent materials and crude parallel to surface carbonate lamellae in coarse grained parent materials, carbonate on underneath side of clasts, typically becomes very dense at 8 inches to 1 foot depth with continuation of the Bt horizon. Thus, lower limits of soil rarely fully excavated within site test pits (exceeds bottom of pit).
S5	**>20 kya but within latest Pleistocene likely** Well developed surface if not eroded away; Bt is yellowish red (2.5 - 7.5YR 5/6 dry, 4/6 moist, , Btk with stage II carbonate, 1/4 to 1/2 inch diameter carbonate concretions, dense, blocky, secondary clay abundant in Bt horizon, soil profile a minimum of 2 feet thick.

LOCAL STRATIGRAPHIC SECTION – GEOLOGIC UNITS

Field mapping on the project site yielded a local stratigraphy of only six units. Stratigraphic relationships between geologic layers and analyisis of preserved soil profiles in turn generated relative and numerical minimum ages for each unit. Plates 2 and 3 are cross sections (A-A' and B-B') with average thickness, depths and stratigraphic relationships of local mapped units. Geologic unit descriptions are provided below from youngest to oldest.

Qw: Active stream wash deposits composed of very fine to very coarse sand with small gravel, light brown (7.5YR 6/3 dry) to yellowish brown (10YR 5/4 dry), and loose. This unit is confined within the active washes and is typically 1 to 6 inches thick in most washes, but may locally be greater than 2 feet thick in some of the larger washes. This unit was not mapped within this study.

Qs: Active, dormant and relict aeolian sand deposits. Very fine to fine sand, yellowish brown (10YR 5/3 to 5/4 damp). Ripple deposits and active ripples commonly are very fine to coarse sand. This unit consists of sand sheets up to 1/3 meter thick accumulated by migrating ripples, small coppice dunes and SSE trending linear dunes.

Qal: Quaternary Alluvium exists across most of the site and is composed of unconsolidated very fine to coarse sand with small gravels, brown (7.5YR 5/3 dry), moderate to well bedded, and loose. This unit typically exhibits an upper member soil Bw horizon ranging in age from 1 to 3 ky (soil designation S3a this report) which commonly overlies buried soils within unit Qal some of which are estimated to be 7 to 8 ky old (soil designation S3a). The soil bearing portions of the unit are generally light yellowish brown (10YR 6/4 dry) to light brown (7.5YR 6/4 dry, 5/4 damp). Smooth gravel lag surfaces overly the older members of this unit. This unit typically overlies older alluvium above elevation 374' msl, or lake deposits below Elevation 374' msl (~ elevation of latest Pleistocene shoreline). Unit Qal appears to be a tabular sedimentary body that extends over the vast majority of the Project (Solar Array and Linears) with an average thickness of 1 foot (see Plate 2 cross section A-A', and Plate 3 cross section B-B').

Qsr: Relict sand sheet and highly degraded small coppice dune deposits. These sediments were deposited within wind transport and depositional areas during the Holocene that are no longer active. Deposits consist of very fine to fine sand, strong brown (7.5YR 6/5 damp), massive to poorly bedded, and loose. Similar to unit Qal this unit commonly exhibits a soil horizons in the upper 2 to 6 inches that ranges in age from 1 to 7 ky old and a very coarse sand to gravel lag wind abrasion surface similar to desert pavement. Unit Qsr is the most common unit exposed on the surface and overlies unit Qal as a tabular sedimentary deposit averaging 4 to 8" thick in sand sheet areas (the most common).

Ql: Lake deposits associated with an ancient playa. Unit Ql is light yellowish brown (10YR 6/4 dry), very fine to medium sandy silt, medium dense to dense, iron oxide stained, massive, medium dense to dense, blocky, and with a densely jointed texture likely due to desiccation cracks. No fossils were encountered during this study.

Qoaf: Older alluvial fan deposits likely associated with regional aggredational depositional events associated with major Pleistocene glaciations. The unit is ubiquitous across the site in the near surface except for below elevation 374' (old shore line) where it may exist at depth. These deposits are distal fan facies consisting of silty fine to very coarse sand with small to medium dense and massive gravels. Unit bears multiple surface soils and paleosols that may be subdivided into additional members. The youngest soil is a minimum 12 to 20 kya old (soil designation S4), and a second common soil is estimated to be older than 20 kya at a minimum.

FINDINGS

Geomorphic features visible on Google Earth and high resolution color orthophotographic images reflect potential ancient lake shore lines within the Ford Dry Lake basin. The area reviewed included the northern and eastern portions of the basin shown on Plate 1. Geomorphic tonal and depositional lineaments noted are probable lake margins from elevations 360 to nearly ~380' msl. This evidence included tonal lineaments that appear to coincide with slight variations in vegetation, surface exposed sediments, and geomorphic variations in channels transverse to contours. A potential lake shore line at upper elevation 379' was identified in the northwestern Ford Dry Lake area based on the exposed upper limit of lake sediments (see Plate 1). This ~380' msl elevation lineament is connected to the 377' lineament toward the east for simplicity. No lineaments were identified within the project site at higher elevations than 377' msl. Geomorphic lineaments believed to be associated with ancient shorelines characteristically become less continuous and difficult to trace for relatively higher shorelines. This reflects the older ages for higher elevation shorelines and subsequent more intensive erosion.

Field verification of the ancient shoreline lineaments proved very difficult to identify and trace on the ground. Numerous test pits were excavated between elevation 363' to 402' msl. Sediments were evaluated to distinguish alluvium (Holocene Qal), playa lake (Ql) and Older Alluvial Fan (latest Pleistocene Qoaf) deposits. Soil profiles were also analyzed to estimate the age of the deposits based on the soil designations (S0 through S5). Plate 1 shows the locations of selected test pit sites that provided temporal and spatial distribution of shore lines in the Ford Dry Lake basin. Cross section C-C' on Plate 3 is a profile with stratigraphic data from numerous test pits against elevation. The cross section shows temporal and spatial relationships of lake shores between elevations 363' and 394' msl.

Field work identified unit Qoaf with a soil profile designation of S4 to S5 from elevation 394' msl down to approximate elevation 374' msl (Cross section C-C'). The minimum age of the local Qoaf at elevation 374' is estimated at 12 kya, but possibly as old as 15 to 20 kya. It is clear that an ancient lake has not existed within the Ford Dry Lake since deposition of Qoaf in the vicinity of cross section C-C' down to elevation 374'. In summary, shore lines 377' to 380' as shown on Plate 1 are older than 12kya and likely as old as 15 to 20 kya and their lake deposits likely exist beneath Qoaf in eastern Ford Dry Lake.

At elevation 373 to 374', Ql deposits identified at numerous localities were deposited on top of unit Qoaf and thus post date the latter. The Ql deposits near the 373 to 374' elevation bear more sand and gravel than Ql deposits at the same elevations on the northern and western sides of the basin. This may be the effect of more intensive wave action along the eastern shore due to strong westerly winds. These Ql deposits exhibited a minimum 12 kya soil (S4) and overly unit Qoaf that exhibited a minimum 12 to 25 kya buried soil (S4 to S5). These data indicate that the ancient lake with high stand to elevation 373' to 374' existed prior to a minimum 12 kya but likely greater than 15 to 20 kya. A similar Ql deposit exhibiting a S4 soil profile was identified at elevation 372' msl.

At elevation 367', Ql deposits were identified that exhibited a S3b soil indicating that these deposits have been abandoned since 8 to 12 kya. At elevation 364', Ql deposits were identified that exhibited a S3a to S3b soil indicating abandonment of that surface since approximately 5 to 12 kya. Finally, at the 360' elevation, Ql deposits were identified that exhibited no soil development suggesting that late Holocene lakes have periodically filled the basin to elevation 360' msl.

Many regional ancient lake studies have been conducted for Mojave Desert basins. For example, in Lake Manix near Barstow California in the Mojave Desert (Reheis, et. al., 2007), the final high lake stand in Lake Manix occurred approximately 22,500 years before present, and gradually lowered to 19,600 years B.P.. Reheis et. al. (2007) indicates that Manix Lake likely experienced a series of ephemeral fluctuating lake stands between approximately 17,000 to 15,000 years B.P. It is clear that a lake high stand reaching an elevation of at least 373' feet msl within the Ford Dry Lake basin would require a climate with much larger effective moisture than exists today. These data are consistent with soil profile minimum numerical age data acquired at the Ford Dry Lake provided in this report and indicates that the age of the 374' msl high lake stand may have occurred 15,000 to 17,000 years ago or more.

Existing data strongly indicate that Ford Dry Lake contained only ephemeral playa lakes verses true perennial pluvial lakes. These data include: lack of well developed beach berm deposits, iron oxide precipitates in near surface Ql deposits (high salinity and 10YR hues), diatom species that required high salinity concentrations and very common to regional playa lakes (Dr. William Orr of Paleontology Associates, personal communication), and poorly sorted and poorly bedded sediments.

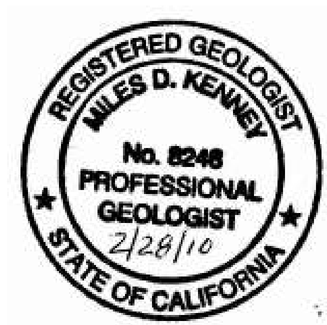
CONCLUSIONS

Evaluation of the data indicates that playa lakes occurred in the Ford Dry Lake basin during the latest Pleistocene to Holocene between elevations 360 to 380' above mean sea level (msl). Shorelines were identified at elevations 360', 370', 373' to 374', 377', and 380' above msl. Lake deposits (unit Ql) were identified with each of these deposits in at least a few localities within the study area. The lineament and geologic data indicates that the highest identified shore lines (i.e. 380' msl) are older while progressively lower elevation ancient shorelines generally decrease in age sequentially. Stratigraphic relationships in addition with estimated age of soils profiles in the upper most members of geologic units (Qal, Ql, and Qoaf) provide information on the timing and history of ancient lakes in the Ford Dry Lake basin.

The latest Pleistocene unit Qoaf provided key cross cutting relationships to indicate that ancient lake stands at elevations 377' and 380' predate a minimum of 12,000 years, and likely predate 15,000 to 20,000 years ago. Soil profiles with an estimated age range of 12,000 to 20,000 years identified in unit Ql associated with the 373' to 374' msl shoreline indicate that the ~374 shoreline likely predates approximately 12,000 years ago at a minimum. The age of relatively younger intervals include a lake stand between 367' and 370' between 8,000 to 12,000 years ago, and at elevation 364' between

5,000 to 12,000 years ago. No soil profiles were identified in limited test sites at approximate elevation 363' suggesting that lake levels during the latest Holocene have possibly inundated to that level.

These are preliminary findings and suggested work for the future if warranted would involve refinement of elevations of areas investigated with good resolution topographic data sets (if available) and a detailed analysis of the soil profiles for better resolve their ages.



Miles Kenney, Ph.D., P.G.
Supervising Geologist

Attachments: References

Plates 1, 2 and 3

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(note: not all publications listed were specifically referenced in this report, but are included as most were in the preparation of this document and others for the project)

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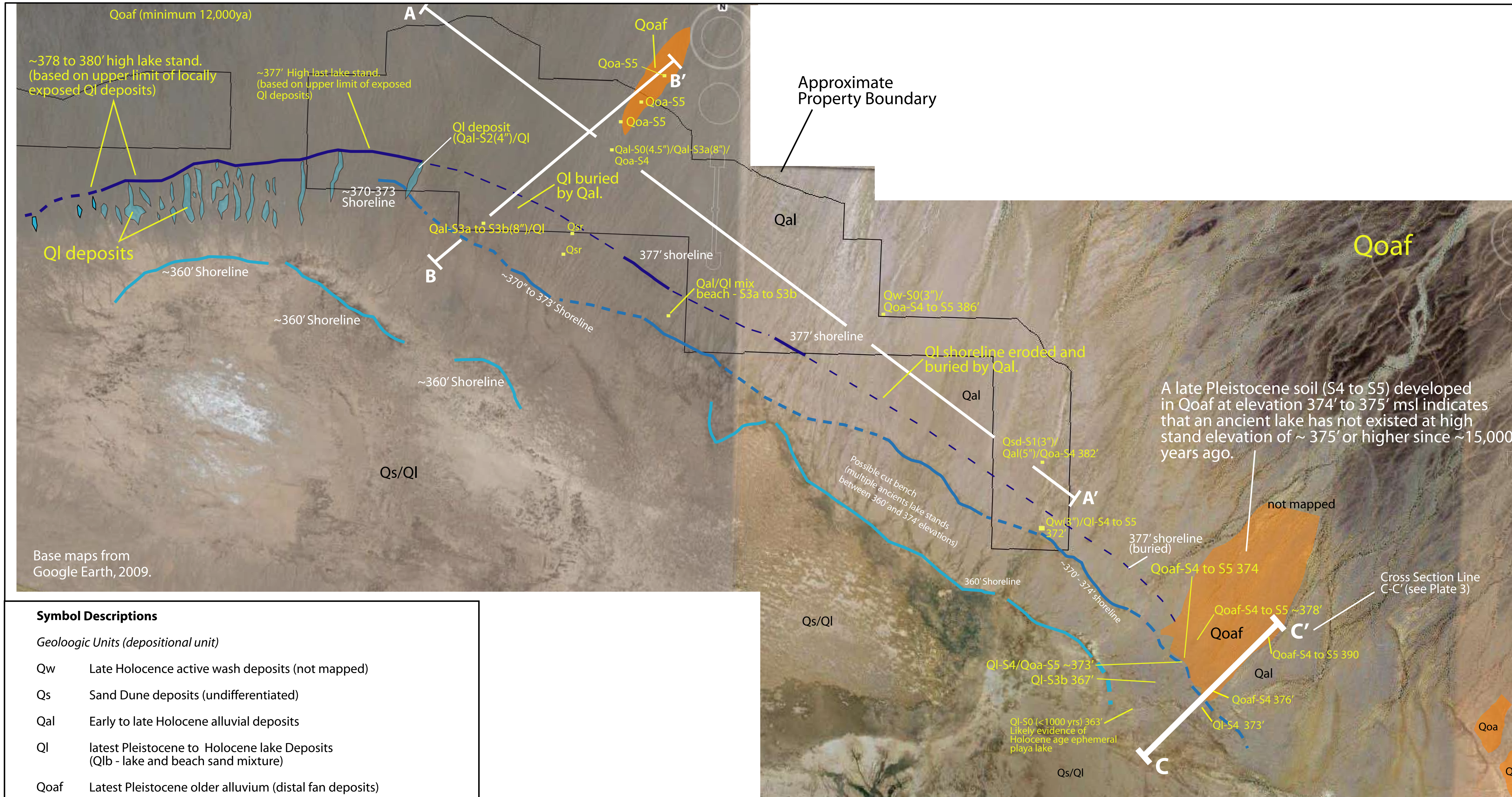

Symbol Descriptions

Geologic Units (depositional unit)

Qw	Late Holocence active wash deposits (not mapped)
Qs	Sand Dune deposits (undifferentiated)
Qal	Early to late Holocene alluvial deposits
Ql	latest Pleistocene to Holocene lake Deposits (Qlb - lake and beach sand mixture)
Qoaf	Latest Pleistocene older alluvium (distal fan deposits)

Soil Profile Designations (Stratigraphy) and Estimated Ages

S0	No soil profile observed (<1 Kya)
S1	1 to 3 ky
S2	3 to 5 ky
S3a	5 to 8 ky
S3b	8 to 12ky
S4	12 to 20ky
S5	20 or older

Nomenclature of Geologic Deposit and Soils

Qal-S2/Qoa-S4 = 3 to 5ky age soil formed in unit Qal, which overlies Quaternary Older alluvium with a soil profile with minimum age of 12 to 20 ky.

Note: All elevations utilized acquired by evaluating Google Earth.

Scale (feet)
0 4245'

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GENESIS SOLAR, LLC

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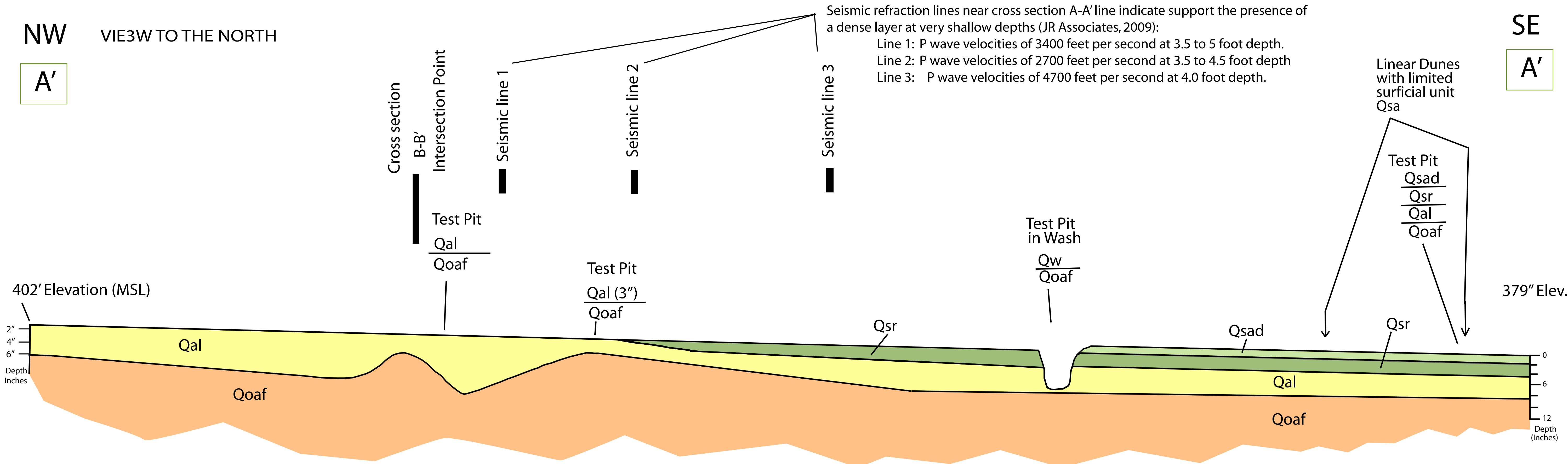
Geomorphic Ancient Lake Shoreline Evaluation Map with Limited Geology, Ford Dry Lake, California

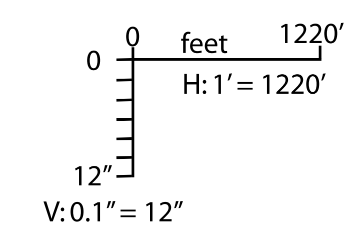
MK	MT	02/05/10
52011206	Plate 1	



SYMBOL DESCRIPTIONS

Qal	Quaternary Alluvium consisting of fluvial distal fan deposits. Within the site these deposits are composed of fine to very coarse sand and small gravel, well bedded and generally only 6-inches to 2-feet thick. Soil horizons indicate that the deposits are between 1ky to approximately 8 ky old.
Qsad	Area dominated by latest Pleistocene to late Holocene stabilized dunes but remain regions of current sand transport with isolated areas exhibiting wind blown sand deposition (sand sheets, coppice and avalanche face of linear dunes). Thus, many areas within mapped Qsad do not exhibit loose sand on the surface and fall under the definition of unit Qsr. Small isolated areas of mapped Qsad also fall under the definition of unit Qsa.
Qsr	Area containing relict wind blown sand sheet and degrading coppice dune sediments with very limited to no active sand transport. These deposits are typically stabilized with grasses, creosote and wind generated very coarse sand to small gravel abrasion lag deposits. The youngest members of this unit exhibit near surface soil Bw soil horizons with an estimated minimum age of 1000 years.
Qoaf	Latest Pleistocene distal fan deposits. They are composed silty fine to very coarse sand and minor small gravel. The unit is generally within 1 to 2 feet of the surface within the Project Solar Array site and exhibits a pedogenic soil horizon sequence that is likely a minimum of latest Pleistocene age.

Scale



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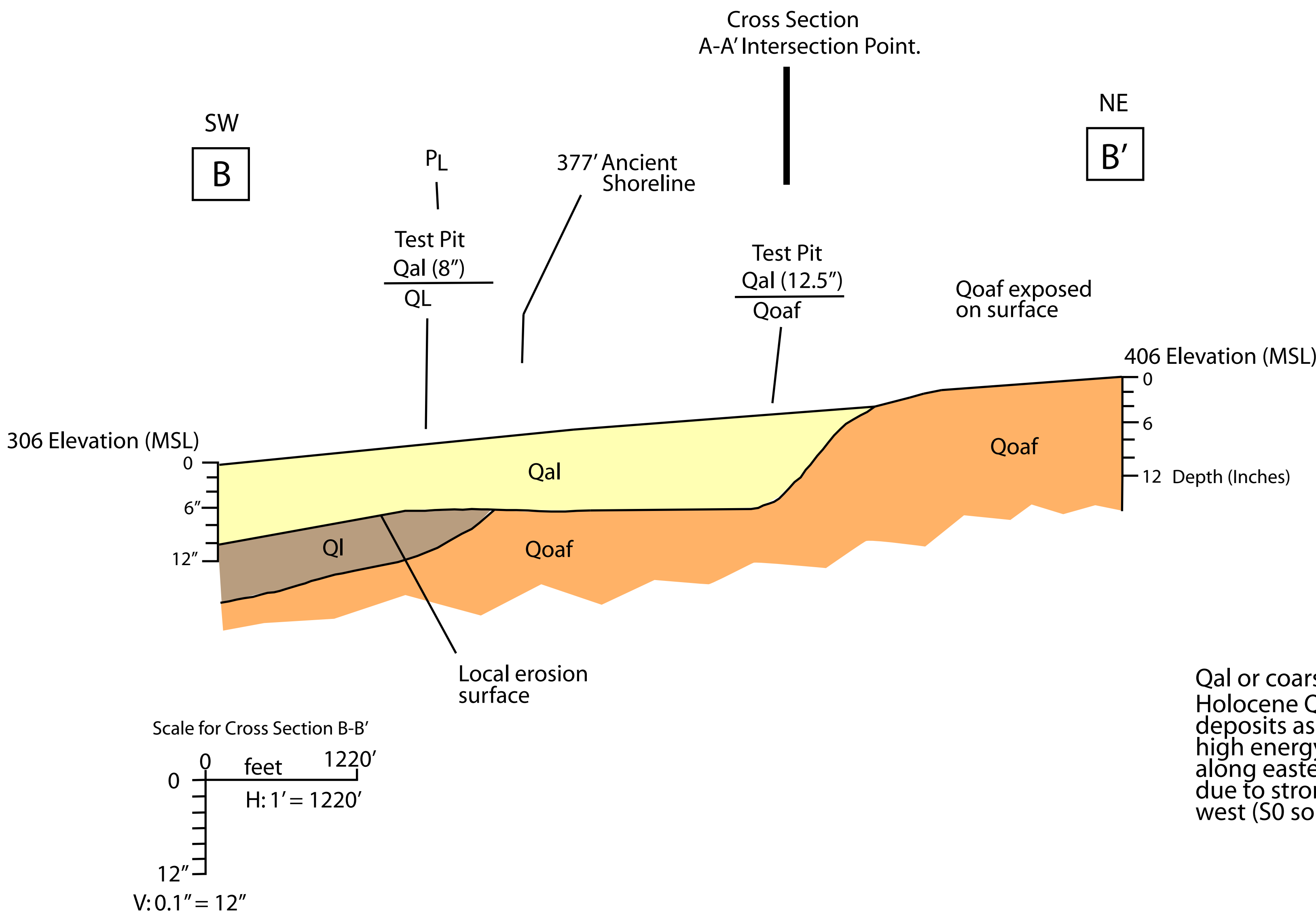
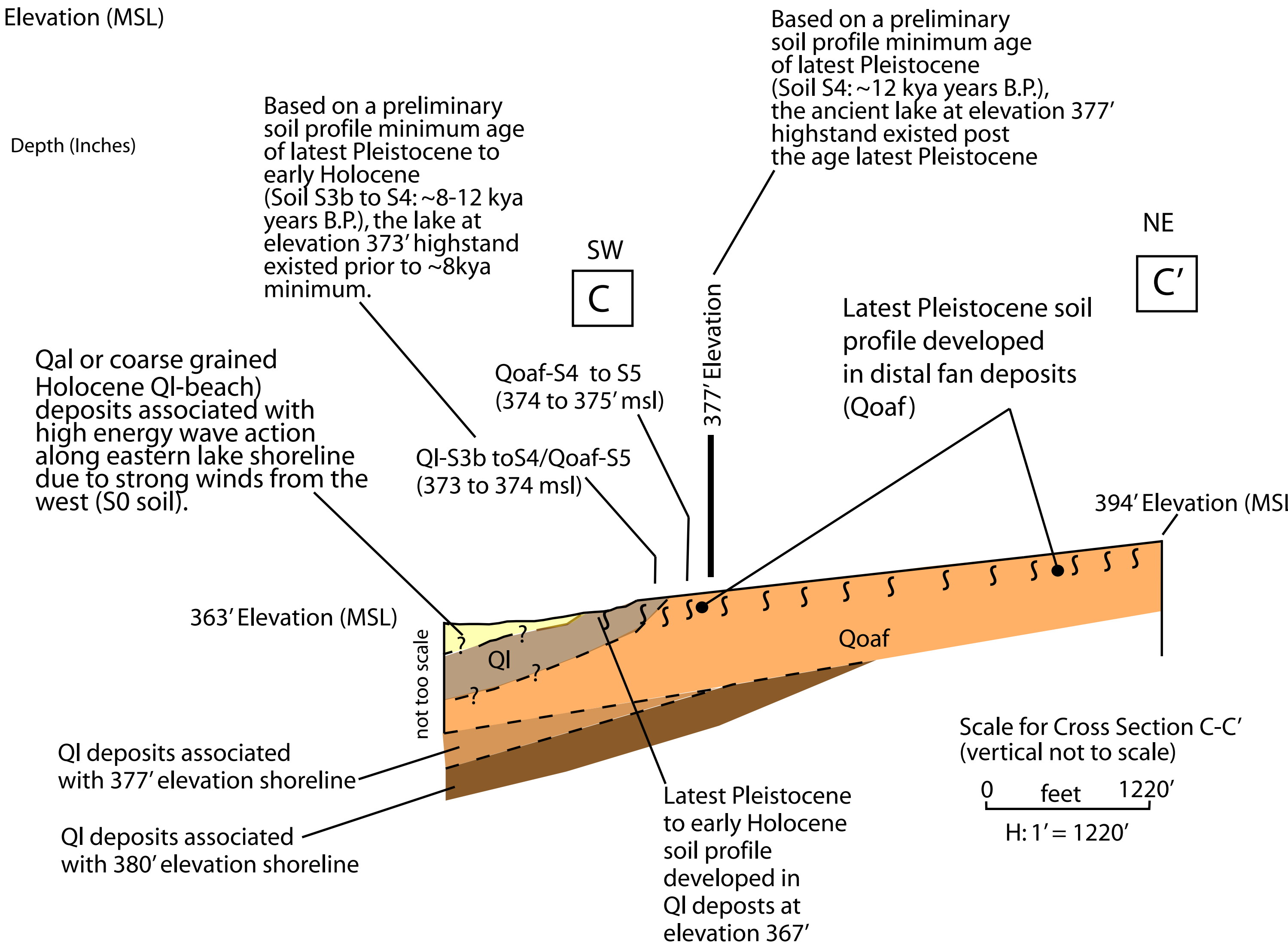
CROSS SECTION A-A′ - GENESIS SOLAR ENERGY PROJECT, CHUCKWALLA VALLEY, CALIFORNIA

MK	MT	02/05/10
52011206	PLATE 2	





Unit Designations:

Qal	Quaternary Alluvium
Ql	Quaternary Playa Lake deposits
Qoaf	Quaternary Older Fan deposits, distal facies

Soil Profile Designation and Associated Preliminary Minimum Ages (kya = 1000 years).

S0	<1000 years No soil development
S1	1 - 3 kya (Cambic Bw horizon)
S2	3 - 5 kya (thin Av and deepening Cambic Bw horizons, minor secondary minerals, carbonate)
S3a	5 - 8 kya (Desert surface, Av-Bw-Bwk - visible carbonate and incepient Bt horizons)
S3b	8 - 12 kya (Well developed desert surface, pink Av, yellowish red Bt, Btk, stage I+ carbonate)
S4	12 - 20 kya (Well developed desert surface, pink Av, 5-7.5YR yellowish red Bt, Btk, stage I+ to II carbonate, dense blocky Bt).
S5	>20 kya but within latest Pleistocene likely (Well developed surface if not eroded away; 2.5 -7.5 YR yellowish red Bt, Btk with stage II carbonate, 1/4 to 1/2″ diameter carbonate concretions, dense, blocky)

GENESIS SOLAR, LLC.

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CROSS SECTIONS B-B′ AND C-C′ - GENESIS SOLAR ENERGY PROJECT, CHUCKWALLA VALLEY, CALIFORNIA

MK	MT	02/05/10
52011206	PLATE 3	

APPENDIX B APPLIED PETROGRAPHIC SERVICES, INC REPORT DATED JANUARY 8, 2010.

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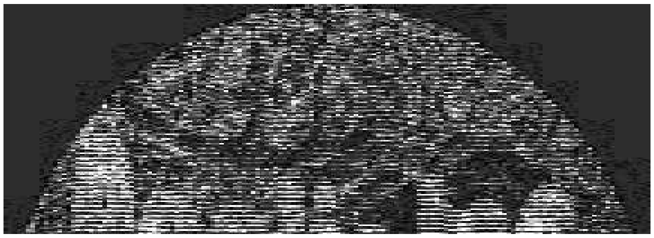
January 8, 2010

APS 1209277

Petrographic Examinations and X-ray Diffraction Analyses Of Twelve Sand Samples

Prepared for Worley Parsons Resources & Energy
By Dipayan Jana
Applied Petrographic Services, Inc.



Applied Petrographic Services, Inc.

Berkshire Center, Suite 103B
4727 Route 30
Greensburg, PA 15601 USA
Phone: 724-834-3559
Fax: 724-834-3556
Toll Free: 1-800-899-0522

January 8, 2010

Miles Kenney
Worley Parsens
215 Calle de Madeva
Encinitas, CA 92024

RE: Petrographic Examinations and X-ray Diffraction Analyses of Twelve Sand Samples

Dear Mr. Kenney:

Enclosed is the report of detailed petrographic examinations, and x-ray diffraction (XRD) analyses of your sand samples.

Also enclosed is a CD including all photomicrographs of your samples.

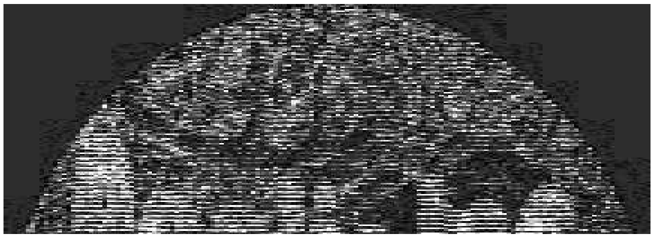
It was a pleasure providing our services to you. If you have any additional questions, please feel free to give us a call. We appreciate your business and hope to provide our services again.

Sincerely,

APPLIED PETROGRAPHIC SERVICES, INC.

Dipayan Jana, PhD, PG
President, Petrographer

DJ:jlh



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Fax: 724-834-3556
Toll Free: 1-800-899-0522

REPORT OF PETROGRAPHIC EXAMINATION

Background

Reported herein are the results of detailed petrographic examinations, and x-ray diffraction analyses of twelve sand samples, received from Miles Kenney of Worley Parsons.

The purposes of the examinations are to determine: (a) detailed mineralogies of the sand samples; and (b) relative proportions of various phases present in the samples.

Methodology & Instrumentation

Petrographic examinations and x-ray diffraction analyses were done for the examinations.

Petrography - For petrography, conventional thin section optical microscopy was done. For thin section preparation, samples were oven-dried, sieved into various size fractions, and individual size fractions were impregnated with a clear epoxy, glued to a glass slide, and thinned down to standard 30-micron thickness. Thin sections were prepared by following the industry-standard methods of thin section preparation, e.g. (i) epoxy impregnation in vacuum and curing, (ii) sectioning, (iii) grinding, (iv) precision sectioning, and (v) precision grinding.

Transmitted-light optical microscopical examinations were carried out by using a research-grade Nikon Labophot 2 Pol petrographic microscope, equipped with a Jenoptik digital camera with Image Pro image capture and analysis software. Several photomicrographs were taken from particles retained in each sieve fraction for each sample during the course of examinations, as shown in Figures 1 through 5.

X-Ray Diffraction – All twelve samples were pulverized to ultrafine (< 10-micron size) powders for x-ray diffraction (XRD) analyses. XRD analyses were carried out by using a Siemens D 3000 Diffractometer, using theta-two theta geometry. Samples were scanned at 2 degrees per minute rate, at 30mA current and 40kv voltage, using a copper Kα radiation. The diffraction patterns were searched for all phases present by using the MDI-Jade 9.0 with search-match module, and, semi-quantitative estimates of phase proportions were calculated by the MDI's easy quant (RIR) module of Jade.

Petrography

The epoxy-impregnated thin sections of various size fractions retained in different sieves for each sample were examined in detail in a petrographic microscope.

Based on detailed optical microscopical examinations, and thin-section-photomicrography as depicted in Figures 1 through 5, the following rock and mineral types were identified:

Sample ID	Coarser Sand Fractions	Finer Sand Fractions	Photomicrographs
S-6	Granite, Shale, Quartz, Quartzite, Limestone, Siltstone, Feldspar	Quartz, Feldspar, Mica, Clay, Calcite	Figure 1
S-17	Granite, Shale, Quartz, Quartzite, Limestone, Siltstone, Feldspar	Quartz, Feldspar, Mica, Clay, Calcite	Figure 2, 3
S-34	Granite, Shale, Quartz, Quartzite, Limestone, Siltstone, Feldspar	Quartz, Feldspar, Mica, Clay, Calcite	Figure 4
S-42	Granite, Shale, Quartz, Quartzite, Limestone, Siltstone, Feldspar	Quartz, Feldspar, Mica, Clay, Calcite	Figure 5

As the above table shows, all four samples examined by optical microscopy are of compositionally similar sands, made using major amounts of siliceous (quartz and feldspar), moderate amount of argillaceous (mica and clay), and trace amounts of calcareous (calcite) components, which are also confirmed by independent XRD studies, the results of which are given below.

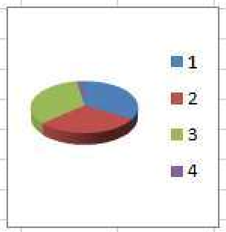
X-ray Diffraction (XRD)

Figures 6 through 17 show x-ray diffraction patterns of all twelve sand samples, where the predominance of siliceous minerals (quartz and feldspar), the next subordinate amount of argillaceous minerals (mica and clay), and trace amounts of calcareous minerals (calcite) are shown. The following Table and Figure 18 summarize results of proportions of different minerals present in all samples (given as percent by mass of sample):

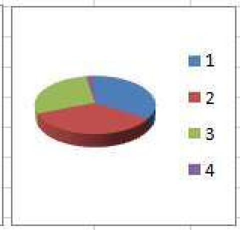
	S-1	S-2	S-6	S-7	S-17	S-18	S-25	S-30	S-31	S-34	S-40	S-42
Quartz	36.0	31.6	33.5	33.9	20.1	20.6	18.4	21.8	30.1	29.3	25.8	19.2
Albite	4.1	6.8	5.5	5.2	9.2	6.5	6.1	6.2	5.3	4.9	7.9	6.4
Anorthite	29.0	17.9	16.4	22.0	38.8	40.2	31.0	27.8	21.7	34.7	36.6	46.7
Microcline	7.3	7.6	7.9	7.9	9.1	11.9	9.6	12.9	10.0	9.1	11.4	13.0
Feldspar	40.4	32.3	29.8	35.1	57.1	58.6	46.7	46.9	37.0	48.7	55.9	66.1
Muscovite	7.4	10.7	14.5	11.7	6.0	8.2	9.5	9.9	11.4	7.3	5.1	5.6
Illite	9.5	14.9	13.7	10.9	10.9	7.2	12.9	11.3	12.4	5.7	7.3	4.8
Kaolinite	4.5	7.0	6.0	5.8	4.5	4.9	6.6	6.5	6.0	3.0	5.0	4.1
Mica and Clay	21.4	32.6	34.2	28.4	21.4	20.3	29.0	27.7	29.8	16.0	17.4	14.5
Calcite	2.2	3.4	2.4	2.6	1.4	0.4	6.0	3.6	3.1	6.0	0.8	0.2

S-1

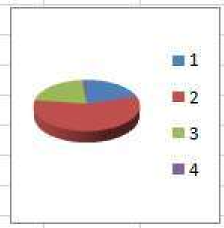
S-2



S-6



S-7

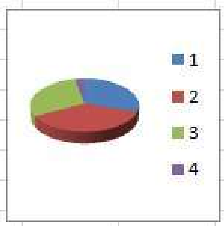


S-17

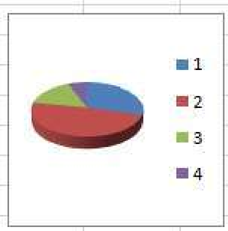
S-18

S-25

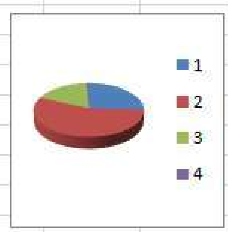
S-30



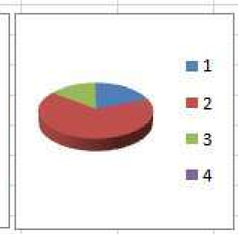
S-31



S-34



S-40



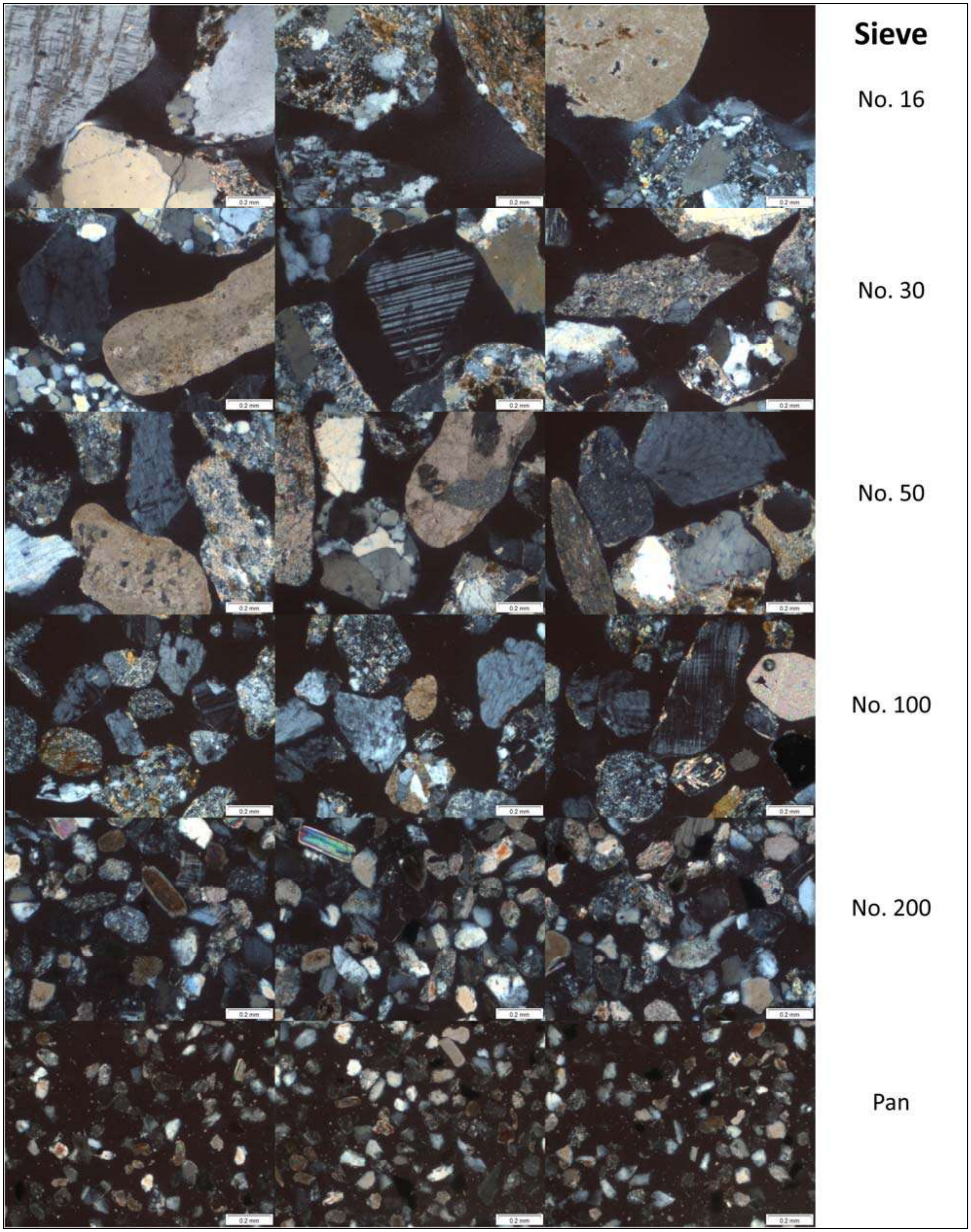
S-42

1 = Quartz; 2 = Feldspar, 3 = Mica + Clay, 4 = Calcite

APPLIED PETROGRAPHIC SERVICES, INC.

Dipayan Jana, PhD, PG
President

DJ:jlh



<u>Figure 1:</u> Photomicrographs of clear epoxy impregnated thin section of Sample No. S-6 showing particles retained in various sieves - - particles contain granite, shale, feldspar, quartz, quartzite, limestone, siltstone at coarser fractions and quartz, feldspar, mica, clay, and calcite at finer fractions.

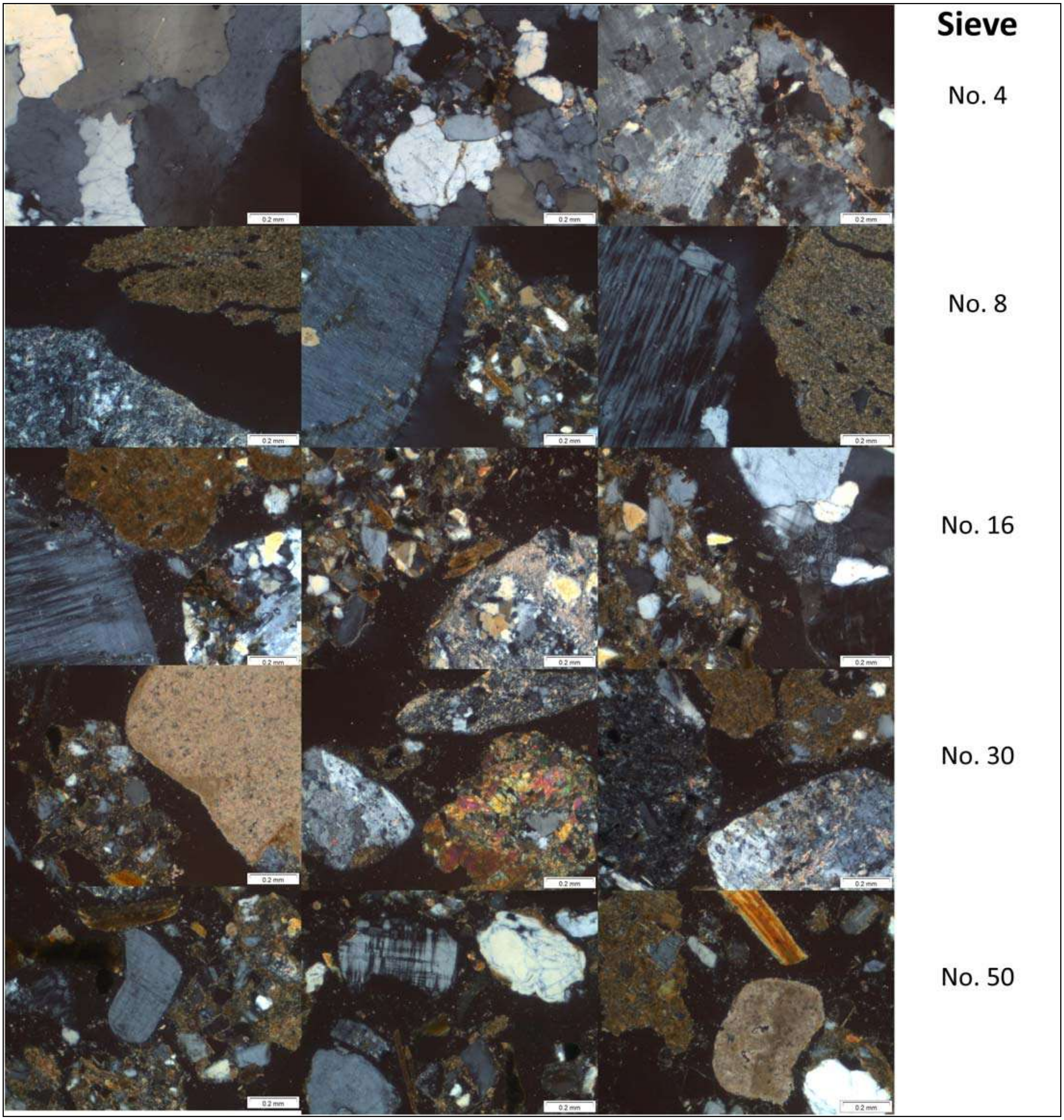


Figure 2: Photomicrographs of clear epoxy impregnated thin section of Sample No. S-17 showing particles retained in sieve Nos. 4 through 50 - - particles contain granite, shale, feldspar, quartz, quartzite, limestone, siltstone at coarser fractions and quartz, feldspar, mica, clay, and calcite at finer fractions.

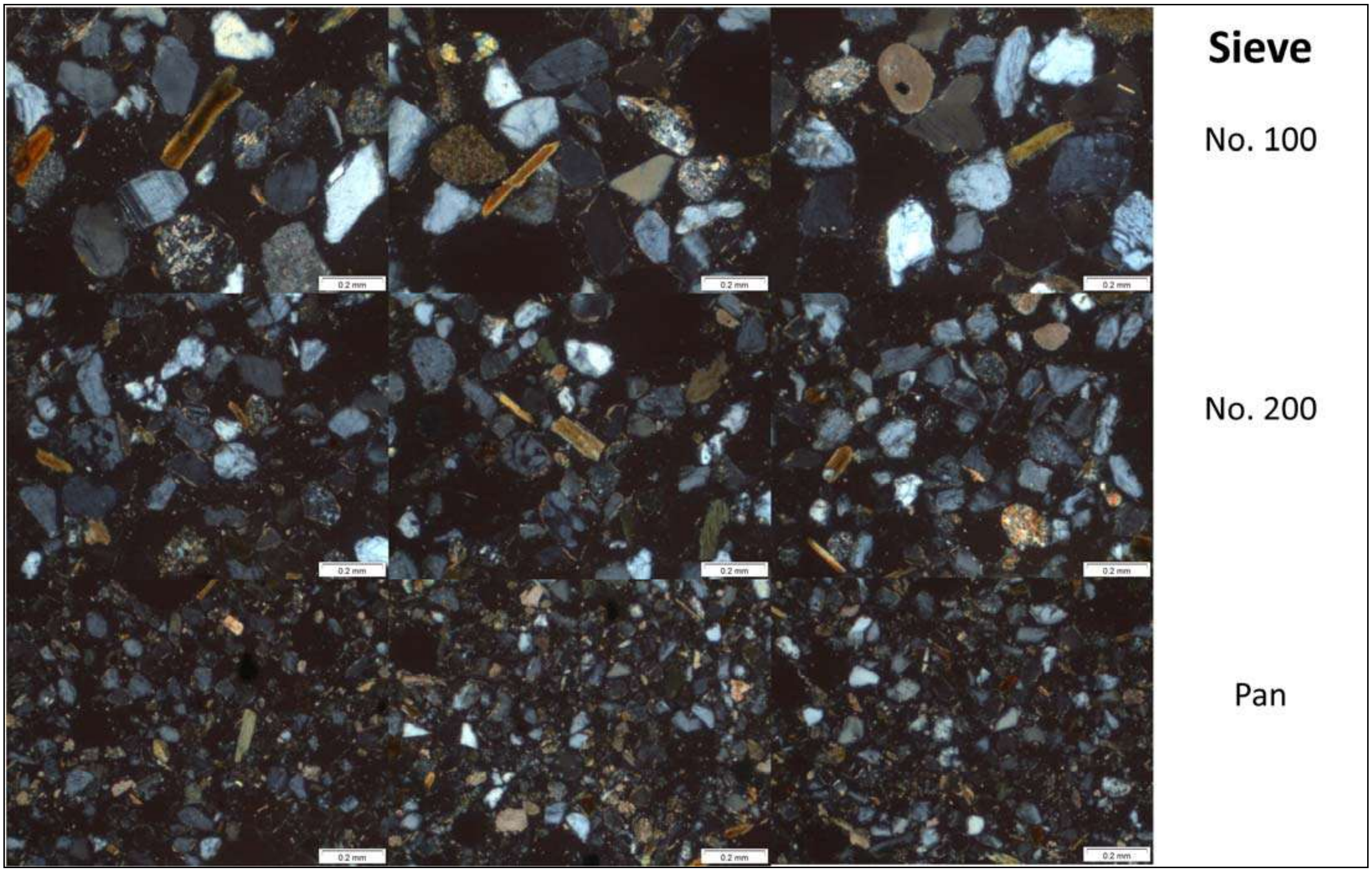


Figure 3: Photomicrographs of clear epoxy impregnated thin section of Sample No. S-17 showing particles retained in sieve Nos. 100 through pan (finer than 75 microns) - - particles contain granite, shale, feldspar, quartz, quartzite, limestone, siltstone at coarser fractions and quartz, feldspar, mica, clay, and calcite at finer fractions.

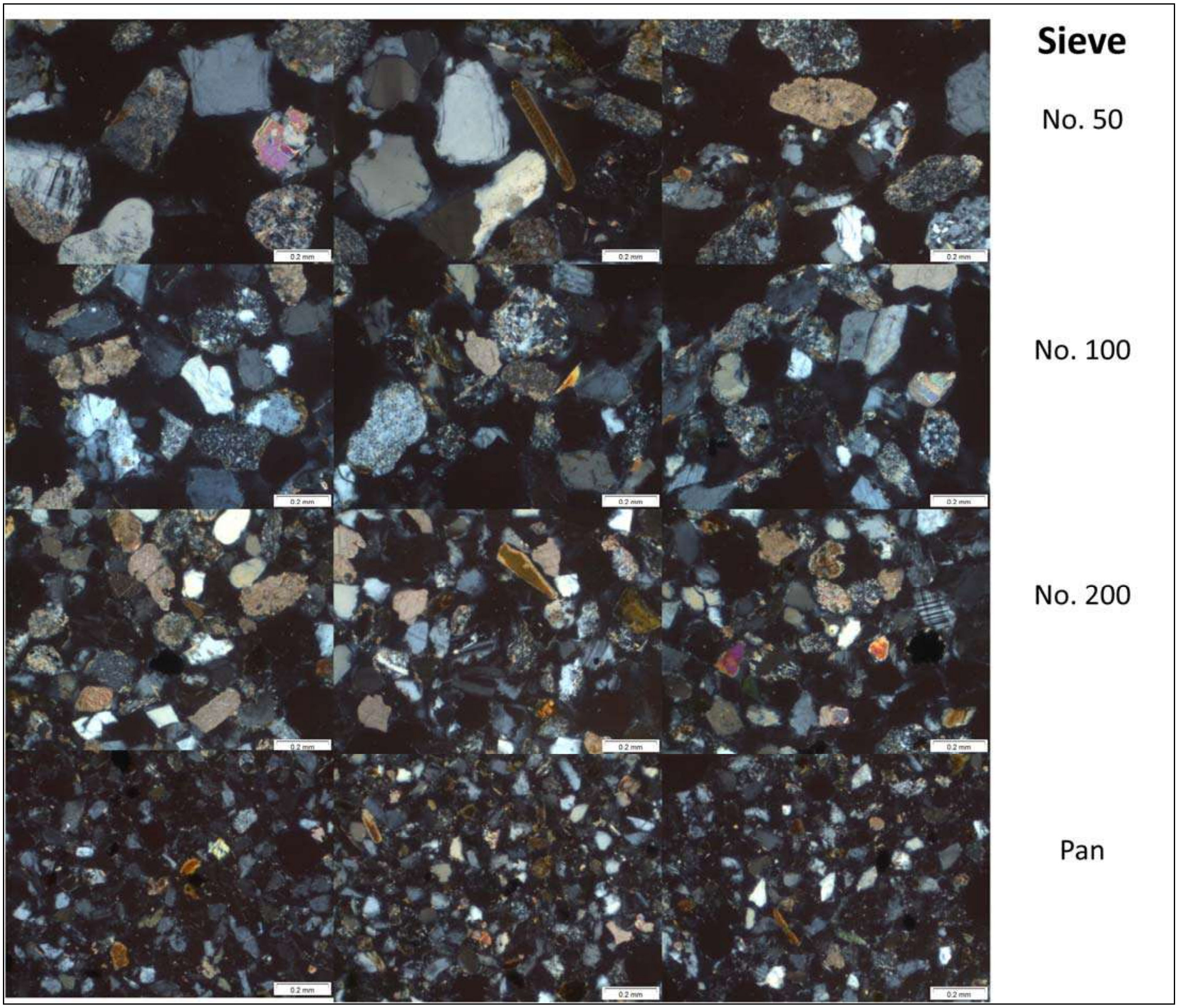


Figure 4: Photomicrographs of clear epoxy impregnated thin section of Sample No. S-34 showing particles retained in sieve Nos. 4 through 50 - - particles contain granite, shale, feldspar, quartz, quartzite, limestone, siltstone at coarser fractions and quartz, feldspar, mica, clay, and calcite at finer fractions.

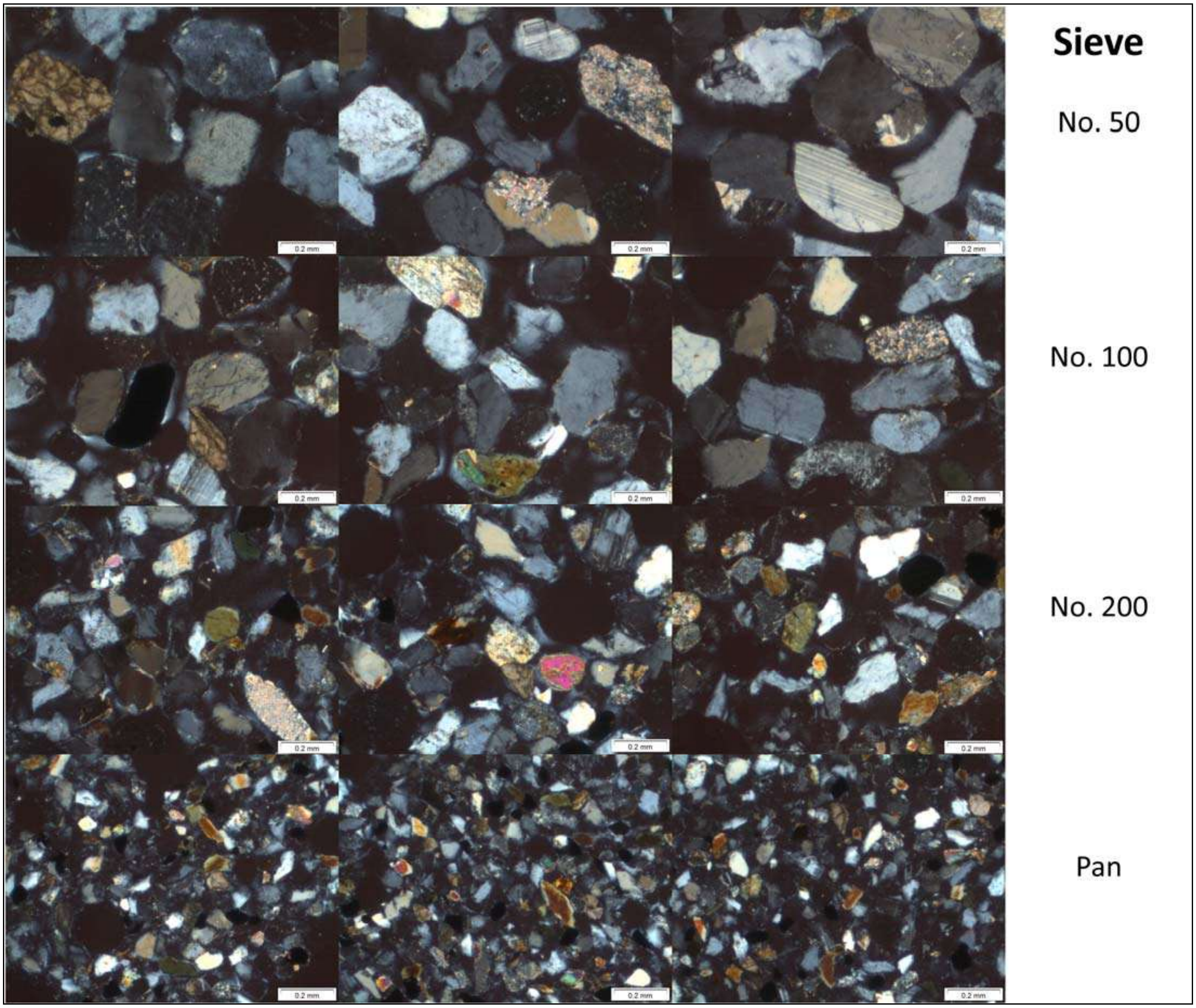


Figure 5: Photomicrographs of clear epoxy impregnated thin section of Sample No. S-42 showing particles retained in sieve Nos. 50 through pan - - particles contain granite, shale, feldspar, quartz, quartzite, limestone, siltstone at coarser fractions and quartz, feldspar, mica, clay, and calcite at finer fractions.

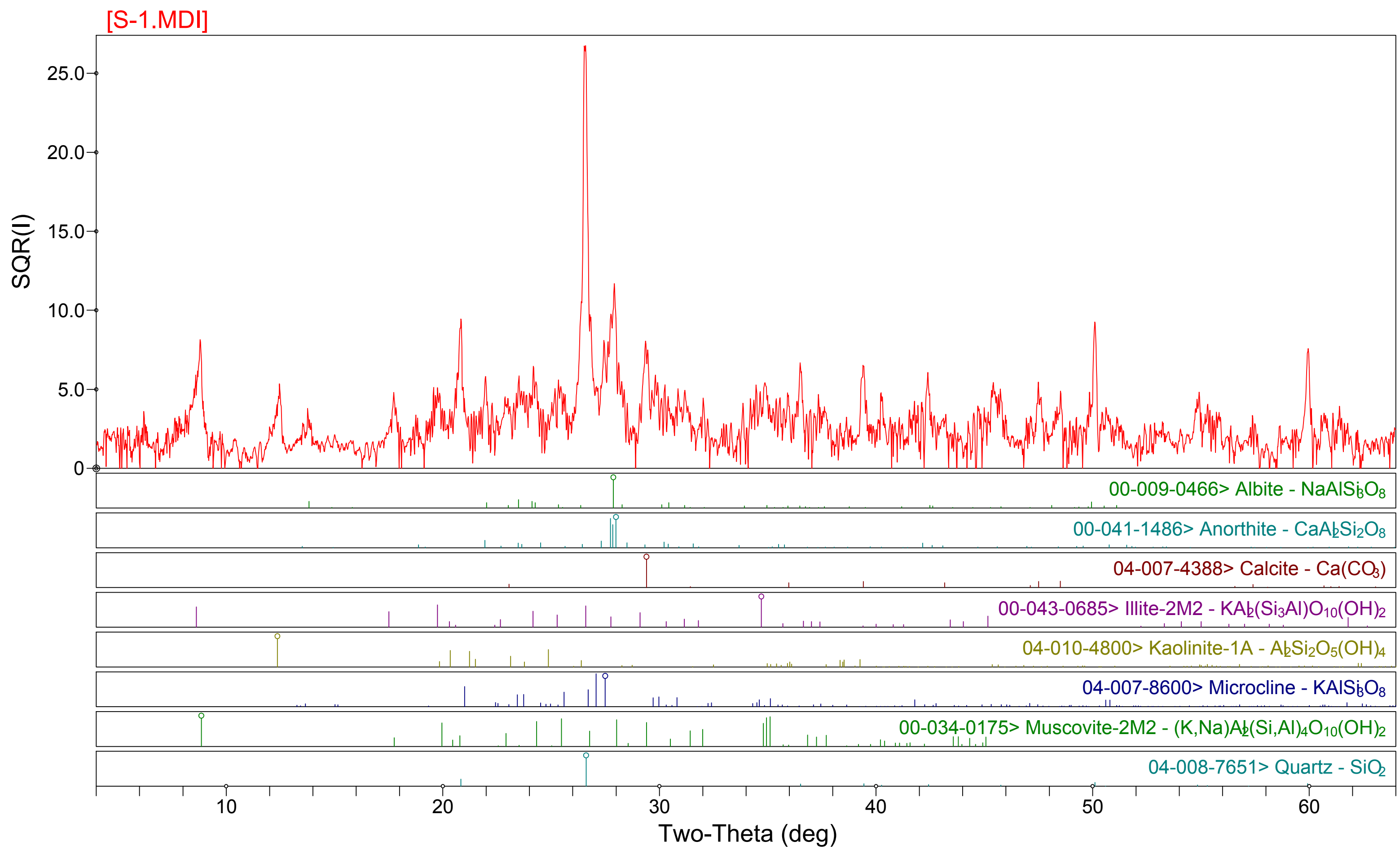


Figure 6: X-ray diffraction pattern of Sample S-1 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite – which are derived from granite, quartzite, limestone, and other rock and mineral fragments determined in thin section studies.

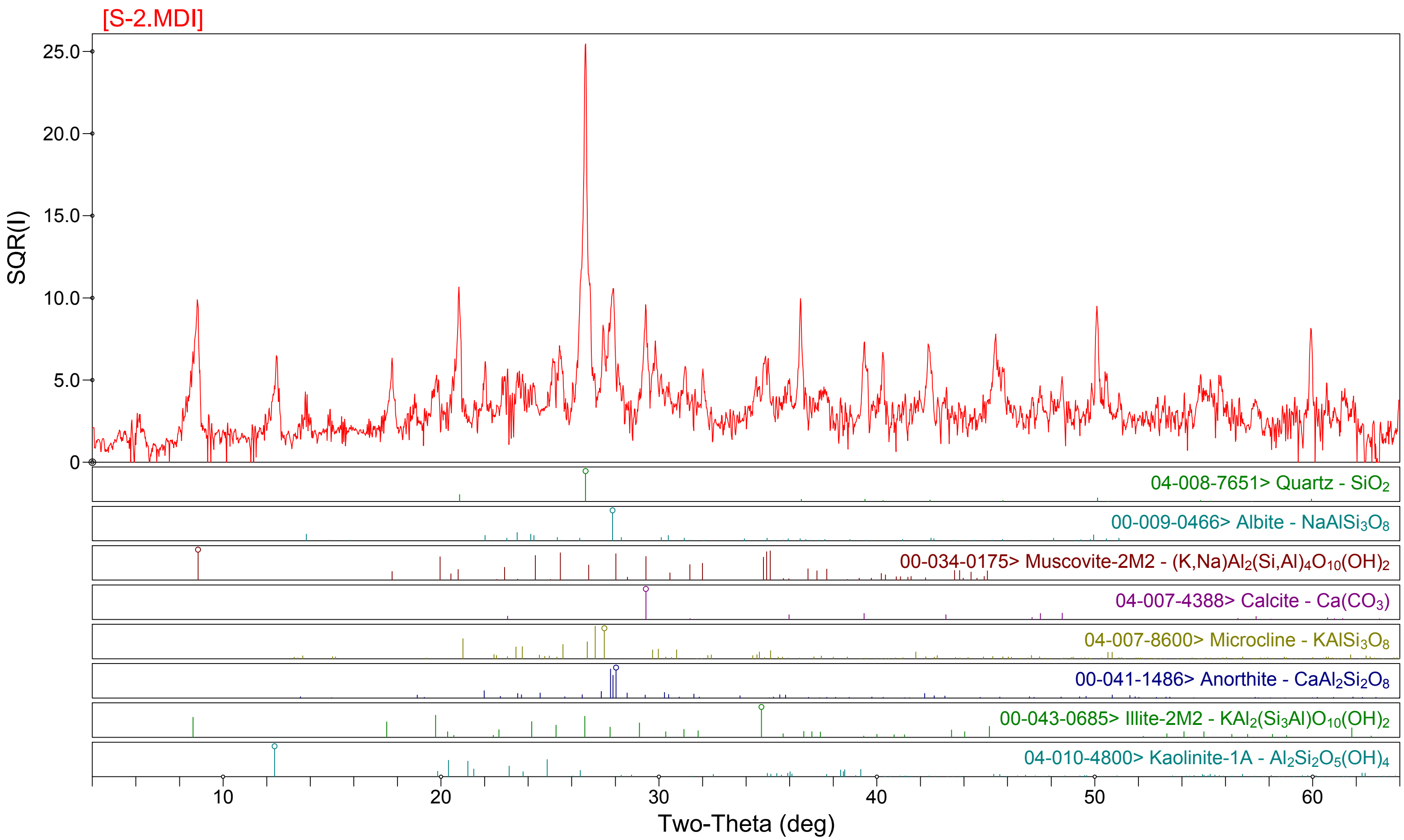


Figure 7: X-ray diffraction pattern of Sample S-2 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

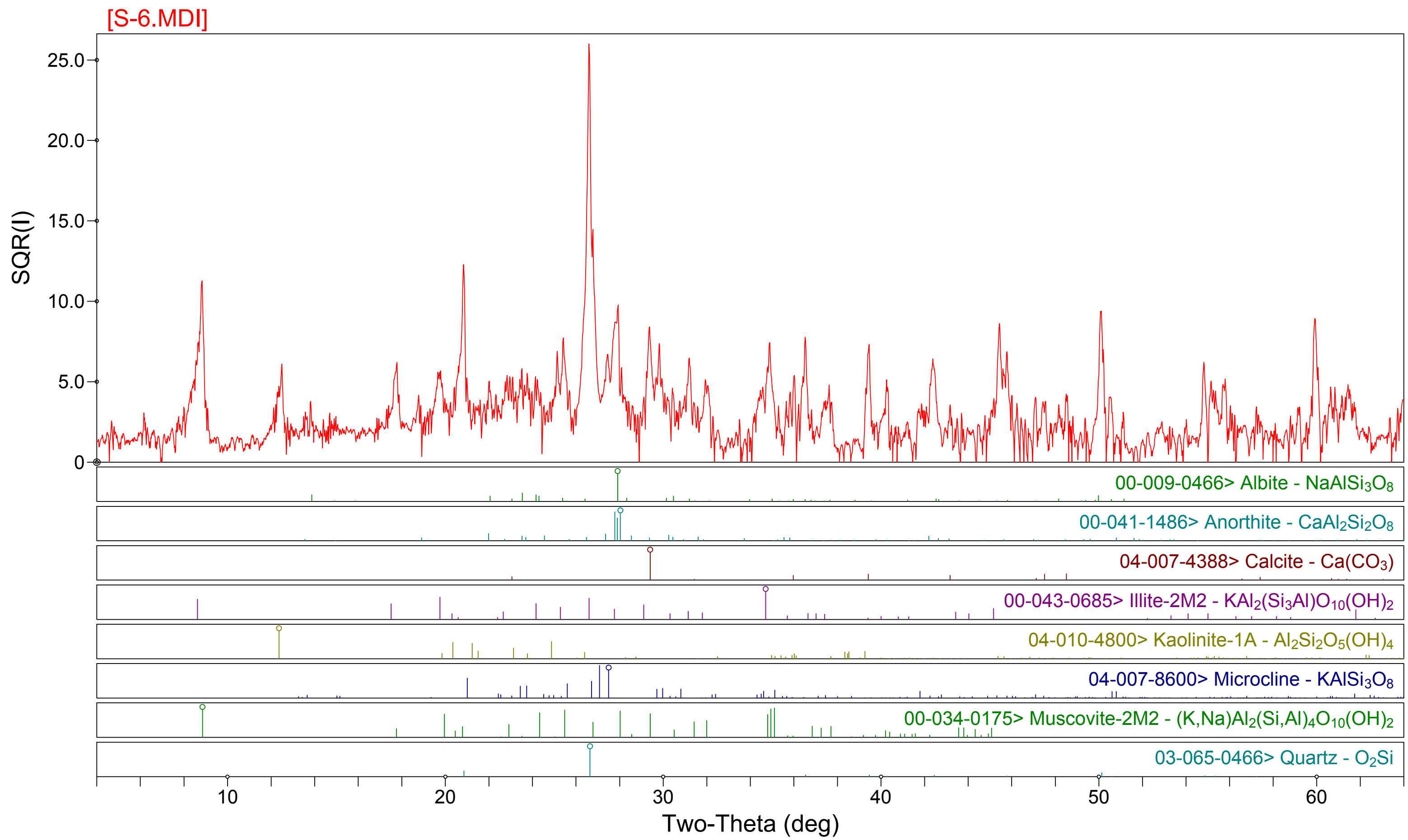


Figure 8: X-ray diffraction pattern of Sample S-6 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

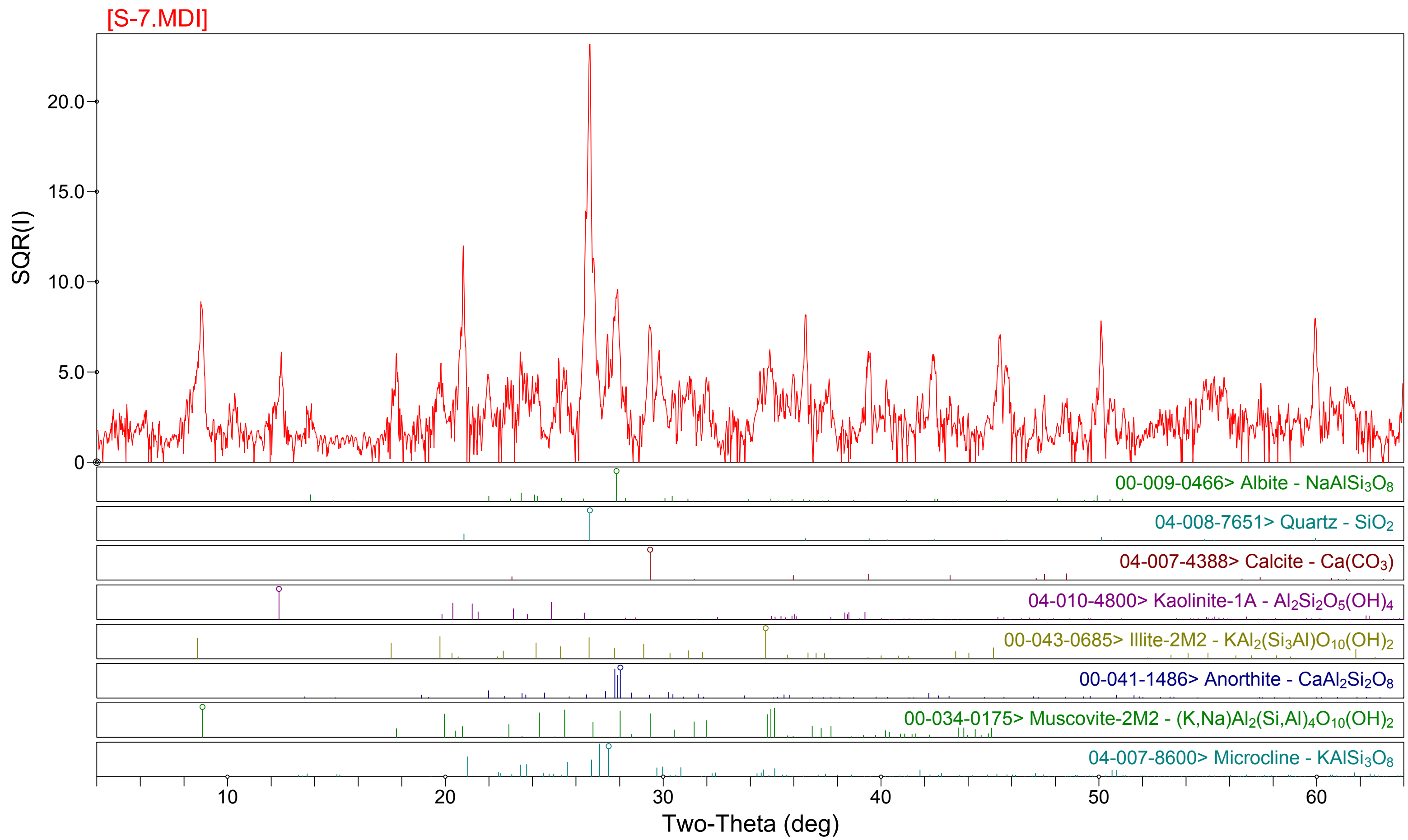


Figure 9: X-ray diffraction pattern of Sample S-7 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

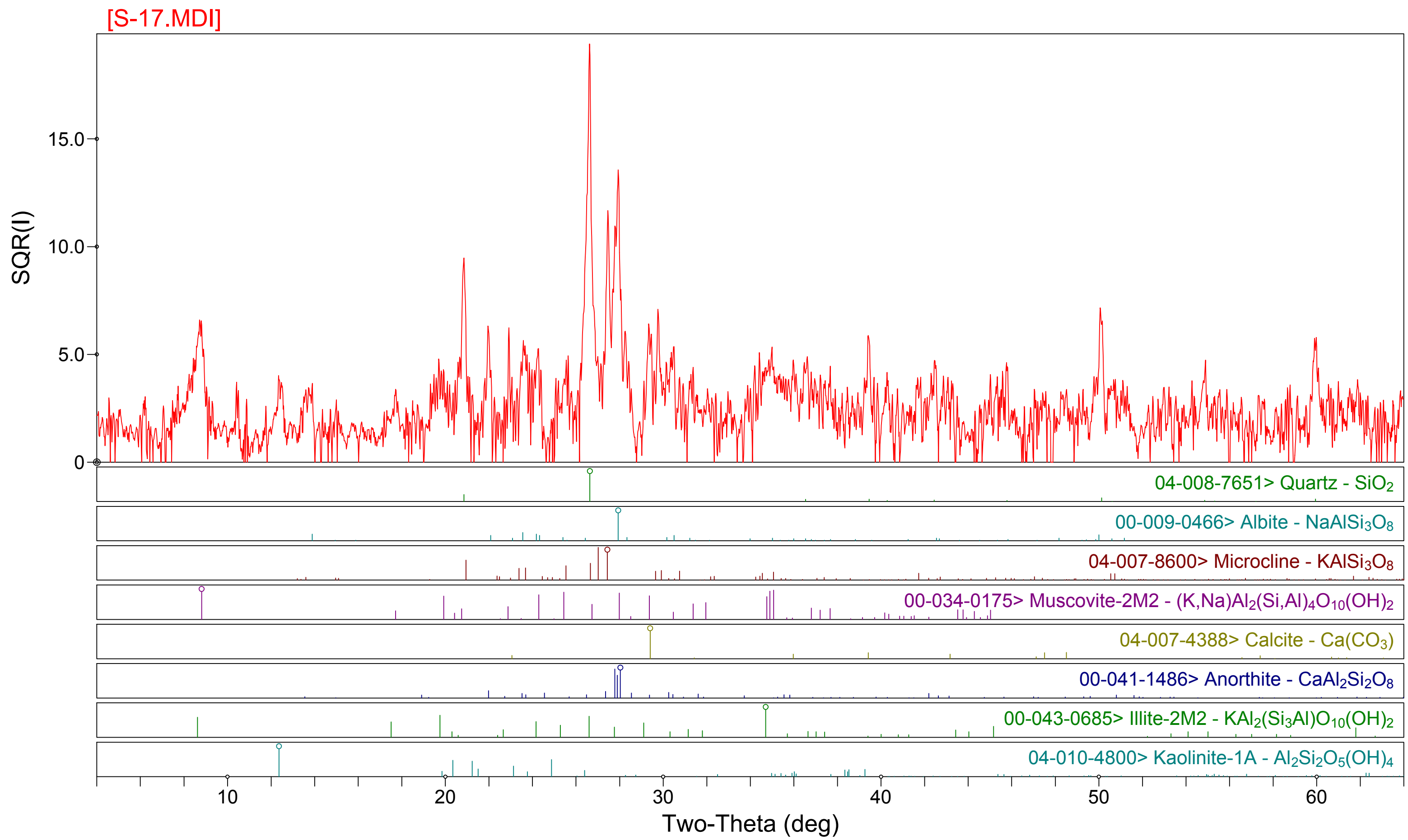


Figure 10: X-ray diffraction pattern of Sample S-17 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

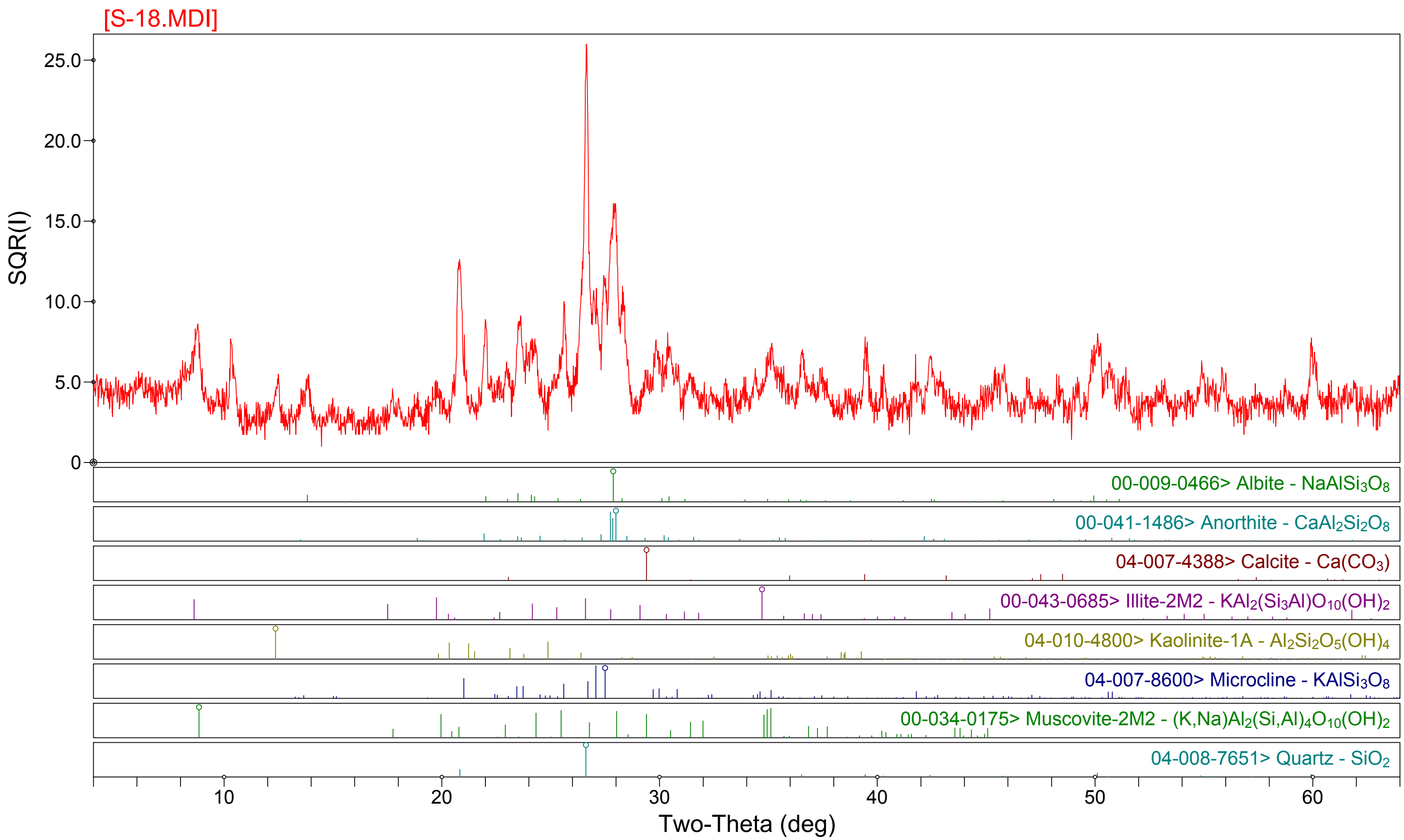
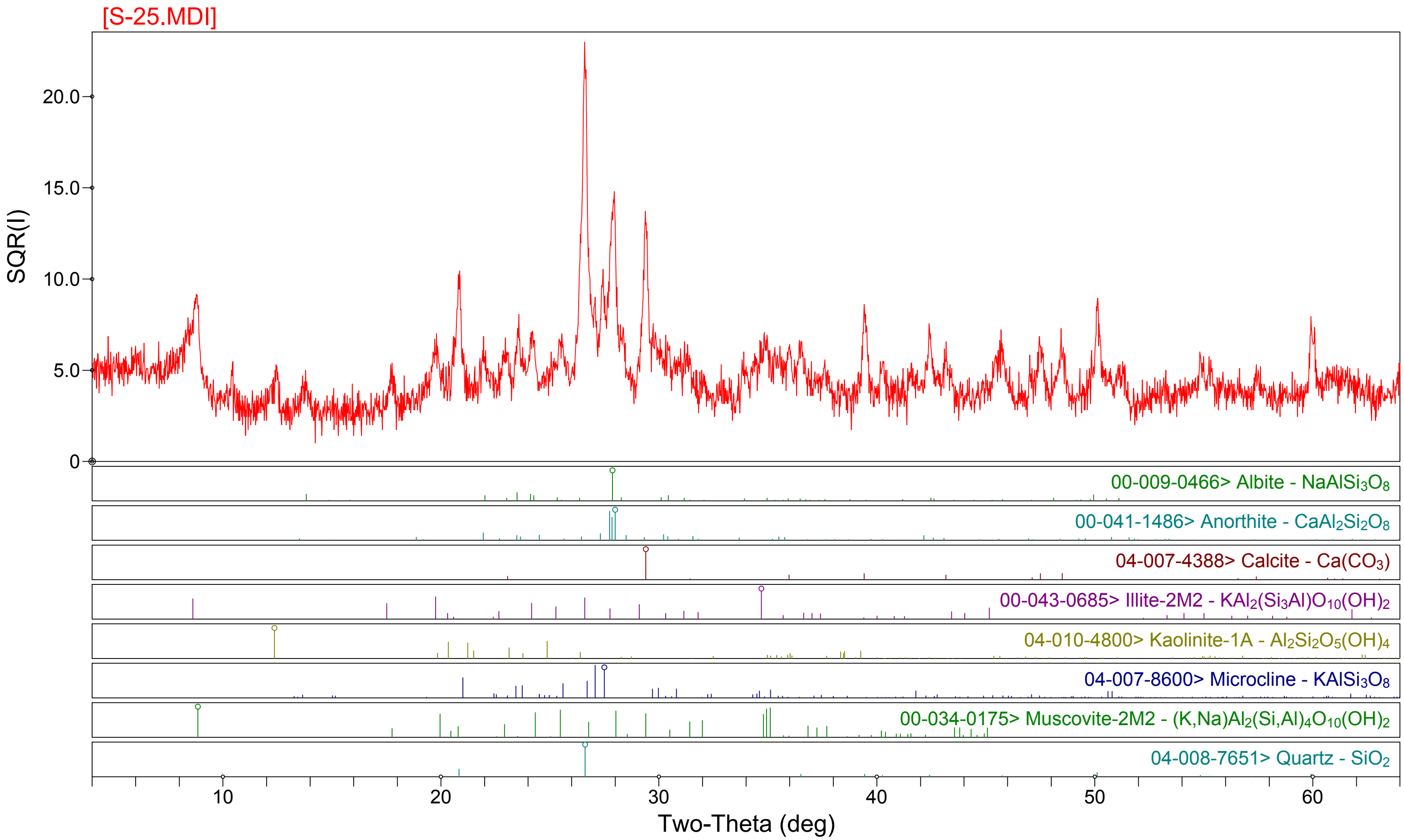


Figure 11: X-ray diffraction pattern of Sample S-18 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.



<u>Figure 12:</u> X-ray diffraction pattern of Sample S-25 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

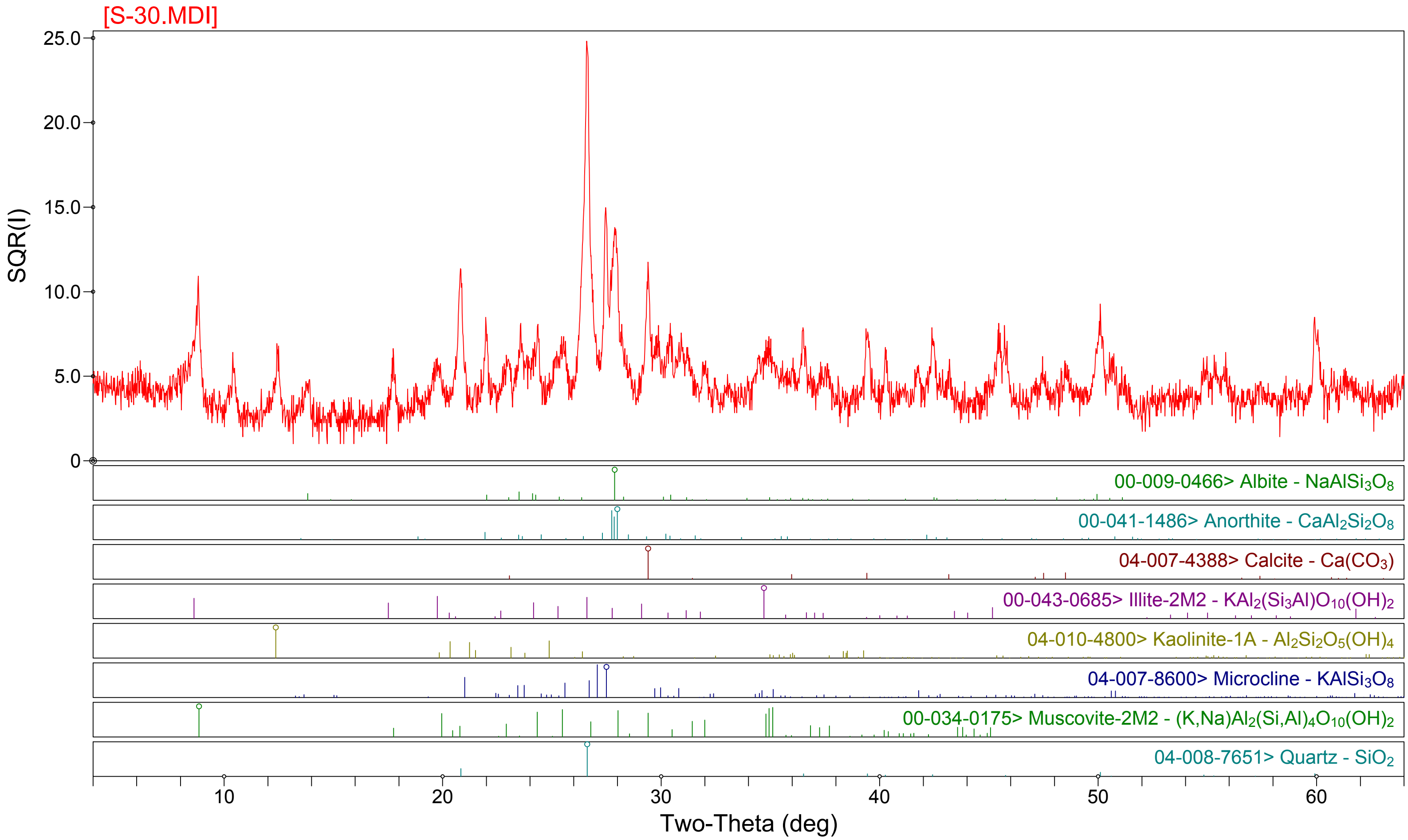


Figure 13: X-ray diffraction pattern of Sample S-30 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

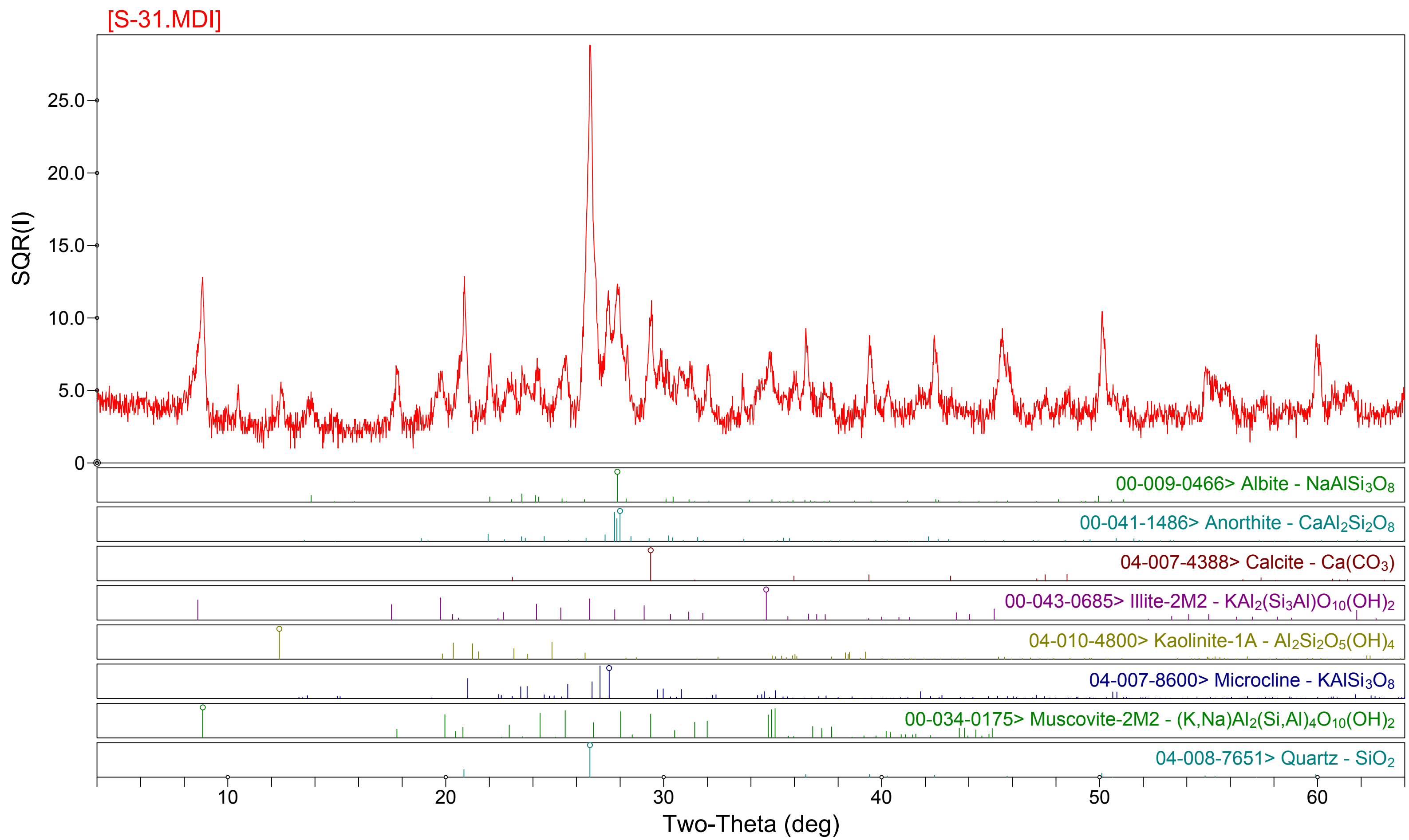


Figure 14: X-ray diffraction pattern of Sample S-31 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

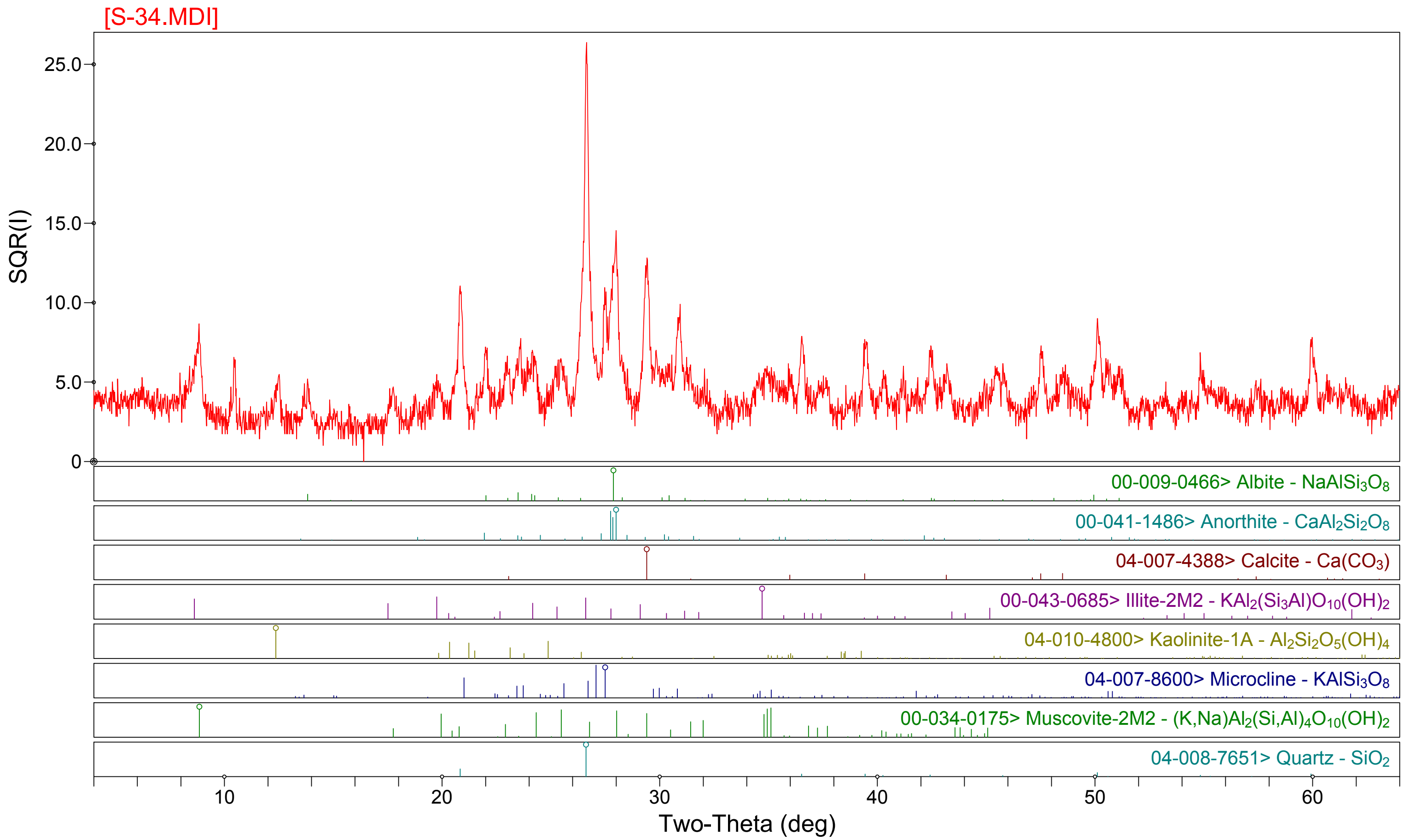


Figure 15: X-ray diffraction pattern of Sample S-34 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

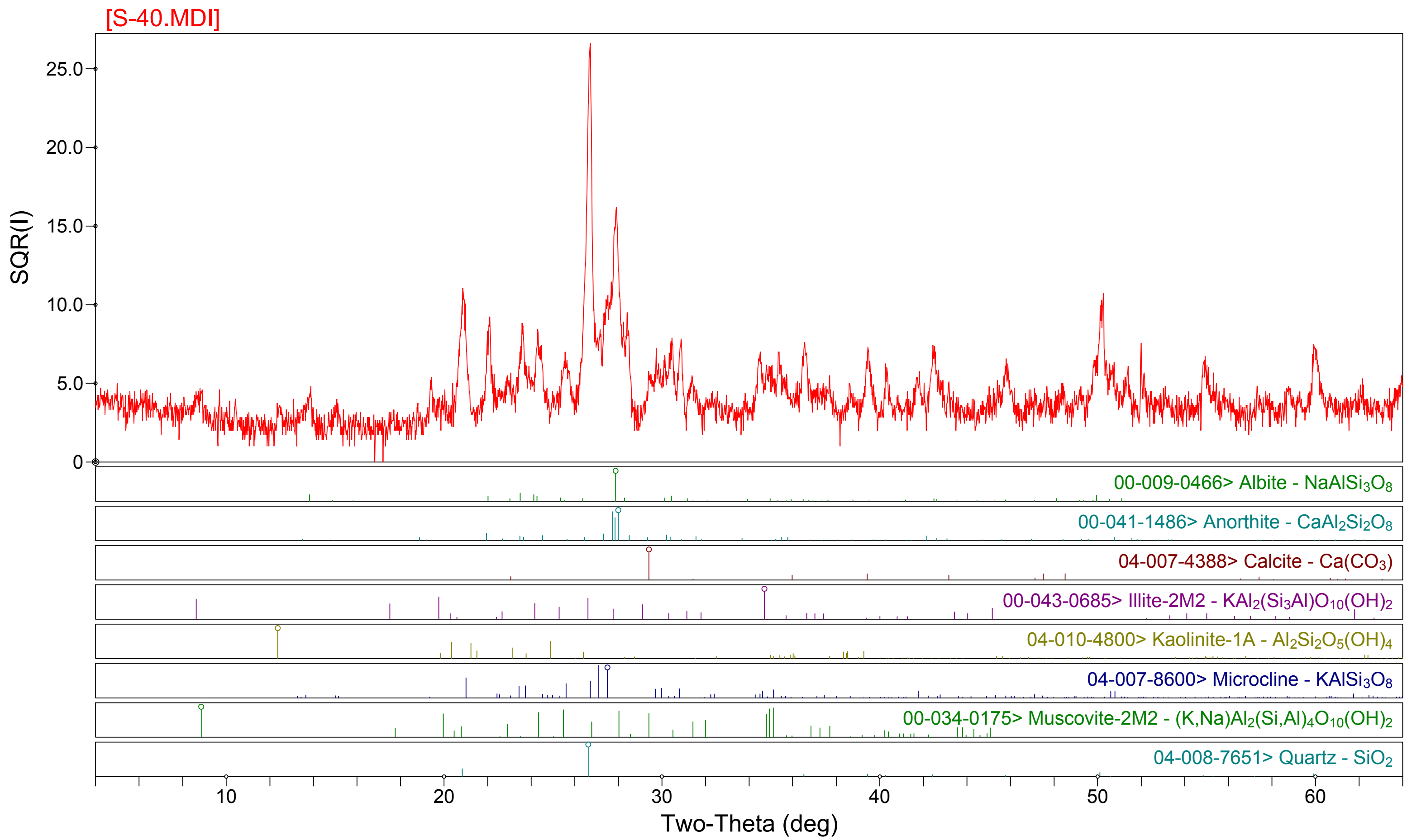


Figure 16: X-ray diffraction pattern of Sample S-40 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

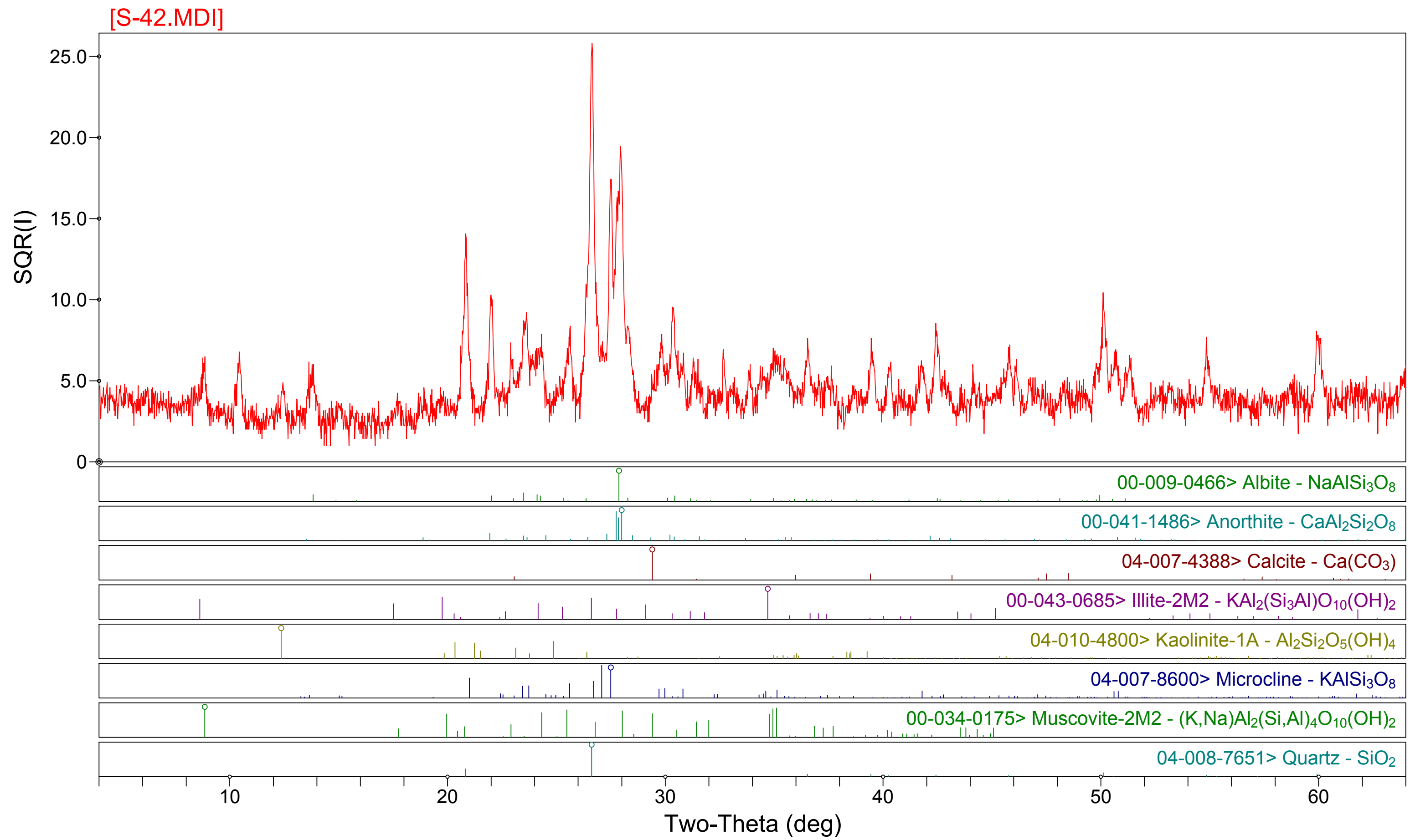


Figure 17: X-ray diffraction pattern of Sample S-42 showing the presence of quartz, various feldspar minerals (albite, anorthite, microcline), mica and clay minerals (muscovite, illite, and kaolinite), and calcite.

	S-1	S-2	S-6	S-7	S-17	S-18	S-25	S-30	S-31	S-34	S-40	S-42
Quartz	36.0	31.6	33.5	33.9	20.1	20.6	18.4	21.8	30.1	29.3	25.8	19.2
Albite	4.1	6.8	5.5	5.2	9.2	6.5	6.1	6.2	5.3	4.9	7.9	6.4
Anorthite	29.0	17.9	16.4	22.0	38.8	40.2	31.0	27.8	21.7	34.7	36.6	46.7
Microcline	7.3	7.6	7.9	7.9	9.1	11.9	9.6	12.9	10.0	9.1	11.4	13.0
Feldspar	40.4	32.3	29.8	35.1	57.1	58.6	46.7	46.9	37.0	48.7	55.9	66.1
Muscovite	7.4	10.7	14.5	11.7	6.0	8.2	9.5	9.9	11.4	7.3	5.1	5.6
Illite	9.5	14.9	13.7	10.9	10.9	7.2	12.9	11.3	12.4	5.7	7.3	4.8
Kaolinite	4.5	7.0	6.0	5.8	4.5	4.9	6.6	6.5	6.0	3.0	5.0	4.1
Mica and Clay	21.4	32.6	34.2	28.4	21.4	20.3	29.0	27.7	29.8	16.0	17.4	14.5
Calcite	2.2	3.4	2.4	2.6	1.4	0.4	6.0	3.6	3.1	6.0	0.8	0.2

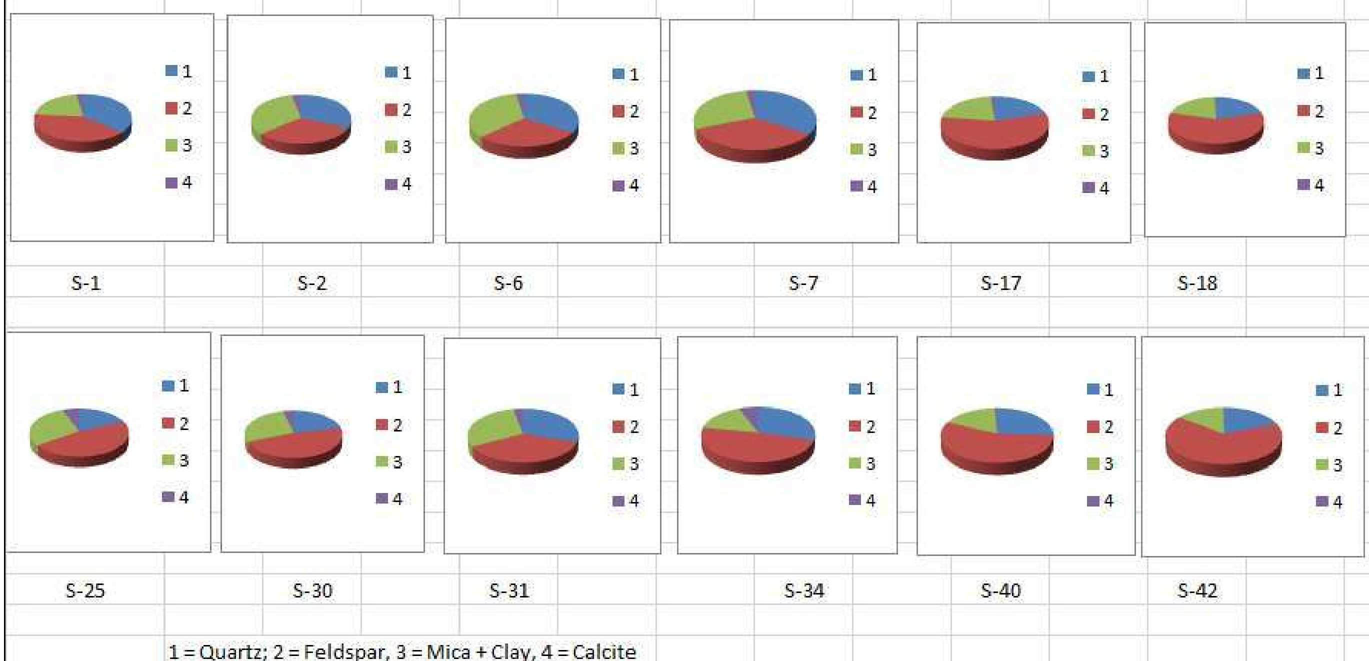


Figure 18: Results of XRD studies of twelve sand samples given in percent by mass of sand for each sample. The pie graphs show relative proportions of major phases in sand.

DECLARATION OF SERVICE

I, Mike Tietze, declare that on February 8, 2010, I served and filed ***Aeolian Transport Evaluation and Ancient Shoreline Delineation Report*** dated February 5, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[http://ww.energy.ca.gov/sitingcases/genesis_solar].**

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

____ sent electronically to all email addresses on the Proof of Service list;

__x__ by personal delivery or by depositing in the United States mail at Sacramento, California with first-class postage thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

__x__ sending an original paper copy, cd, and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

_____ depositing in the mail an original and 8 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 09-AFC-8
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

Original Signed By:

Michael Tietze

*indicates change