United States Department of Agriculture | Soil Conservation Service | Northeast NTC 160 East 7th Street Chester, PA 19013-6092

Subject: Ground-penetrating Radar Survey, Navy Pacific Missile Range Facility 19 - 28 January 1992 **Date:** 12 February 1992

To: Dennis R. Gallien
CSSD EN-V
Department of the Army
U. S. Army Strategic Defense Command Huntsville
P. O. Box 1500
Huntsville, AL 35807-3801

Tirzo Gonzalez
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Purpose:
To assist U.S. Army Strategic Defense Command (USASDC) conduct archaeological investigations within the Navy Pacific Missile Range Facility (PMRF) in western Kauai. The use of ground-penetrating radar (GPR) techniques was recommended as a rapid, non-destructive means for the expanded investigation and analysis of cultural resources within the proposed site of a fuel storage facility.

Principal Participants:

Jim Doolittle, Soil Specialist, SCS, Chester, PA
Tirzo Gonzalez, Senior Archaeologist, ASI, San Diego, CA
Richard Olson, Project Archaeologist, ASI, San Diego, CA

Activities:

Preliminary grid surveying and site preparations were completed by Tirzo Gonzalez and Richard Olson during the period of 16 to 19 January 1992. The GPR unit was unpacked, assembled, and site calibration trials were completed on 20 January. Also on 20 January, additional survey lines were laid out on the proposed access roads and pads. The remainder of the week was devoted to GPR surveys, data interpretation, and ground-truth verification of the radar imagery. The radar unit was packaged and delivered to the air terminal in Lihue on 27 January 1992.

Equipment

The radar unit used in this study is the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey System, Inc. The SIR System-8 is an impulse radar unit. Components of the SIR System-8 used in this survey included the Model 4800 control unit, ADTEK SR 8004H graphic recorder, power distribution unit, 30 meter transmission cable, and 500 MHz antennas. The system was powered by a 12-volt vehicular battery. A 120 Mhz antenna was damaged in shipment and could not be used in this field investigation. As the 500 Mhz antenna provided adequate (@ 2.7 m) depth of penetration and superior resolution of subsurface features, the survey was not impaired by the unavailability of the 120 MHz antenna.

Calibration trials were conducted over a buried metallic reflector. The reflector was buried at a depth of 50 cm. For the sandy soils at PMRF, the calculated velocity of signal propagation was 0.45 ft/ns and the dielectric permittivity was 4.9. Based on calibration trials, a two-way travel time of 40 nanoseconds and a scan rate of 25.6 KHZ were used for the surveys conducted at PMRF.

The radar data was not stored on magnetic tapes. All graphic profiles were returned to Tirzo Gonzalez under a separate cover letter. No signal processing or data analysis was conducted.

Survey Procedures

The survey intervals used in this study were based upon the assumptions of the probable size and concentrations of buried cultural features, desired detection probability, and available time. The 500 MHz antenna, which has a width of about 30 cm and weighs about 4 kg, was pulled along survey or grid lines. As the antenna was pulled past each referenced (flagged) position (spaced at 1.0 to 10.0 meter intervals), the operator impressed dashed, vertical marks on the radar profile (see Figure 2).

<u>Proposed asphalt roadway:</u>
A proposed 3.65 meters wide, 280 meters long, asphalt roadway will provide access to three pads (decontamination pad, nitrogen tetroxide holding pad, and hydrazine holding pad). The center line of this roadway was located and delineated with survey flags placed at 10-meter intervals. Transverse to the flagged, center-line positions, four additional survey flags were placed in the ground at 1-meter intervals. This provided five (including the center line), 280-meter survey lines within a 4 by 280 meter corridor for the proposed access road (see Figure 1).

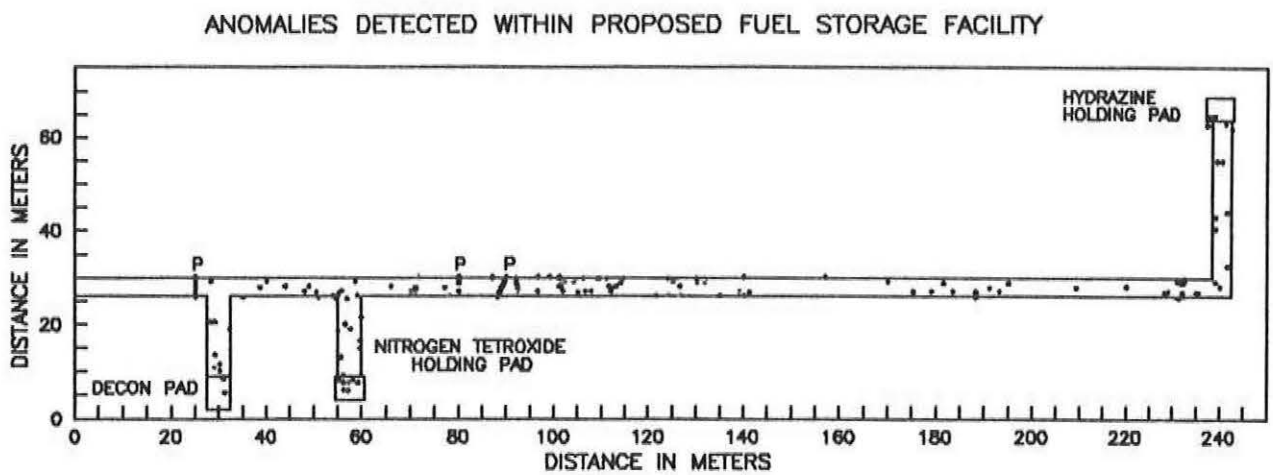

Figure 1

Location of subsurface point anomalies detected with the GPR.

Surveys were conducted by towing the antenna at a very-slow walking pace behind a vehicle housing the radar control and recording units. Traverses were made with the 500 Mhz antenna along each side of the five, 280-meter survey lines. A total of 10 traverse were completed. These traverses provided 2800 meters of continuous, subsurface data, and a 60 % coverage of the proposed access road corridor.

Following interpretation of the radar profiles, 15 segments were resurveyed with flags placed at 1-meter intervals. These segments were selected because of the appearance on radar profiles of unique reflections from subsurface anomalies. The 1-meter interval enabled a more precise location of the detected, subsurface anomalies.

<u>Pad #1 - Decontamination Pad</u>
A 1-meter interval was used to construct a 7 x 5 m grid over the proposed area (4 x 7 m) for the decontamination pad. Traverses

were made with the 500 Mhz antenna along one side (seaward) of each of the six, 7-m survey lines. These traverses provided 42 meters of continuous, subsurface data.

Survey lines from the pad were extended to cover the area of a short access road which will connect the pad with the proposed asphalt roadway. Survey flags were placed at 5-meter intervals along these lines. Traverses were made along one side (seaward) of each of the six, 7 m survey lines. These traverses provided 102 meters of continuous, subsurface radar data.

The radar survey provided a 36 % coverage of the proposed decontamination pad and short access road. The survey was conducted with the survey vehicle in a stationary position and the antenna towed by hand at a very-slow waking pace along each survey line.

Following interpretation of the radar profiles, two segments were resurveyed with flags placed at 1 meter intervals. These segments were selected because of the appearance on radar profiles of unique reflections from subsurface anomalies. The 1-meter interval enabled a more precise location of the detected, subsurface anomalies.

Pad #2 - Nitrogen Tetroxide Holding Pad

A 1-meter interval was used to construct a 5 x 6 m grid over the proposed area (3 x 3 m) of the nitrogen tetroxide holding pad . Traverses were made with the 500 Mhz antenna along one side (seaward) of each of the seven, 5-m survey lines. These traverses provided 35 meters of continuous, subsurface data.

Survey lines from the pad were extended to cover the area of a short access road which will connected the pad with the proposed asphalt roadway. Survey flags were placed at 5-meter intervals along these lines. Traverses were made along one side (seaward) of each of the six, 17-m survey lines. These traverses provided 102 meters of continuous, subsurface radar data.

The radar survey provided a 36 % coverage of the proposed nitrogen tetroxide holding pad and short access road. The survey was conducted with the survey vehicle in a stationary position and the antenna towed by hand at a very-slow walking pace along each survey line.

Following interpretation of the radar profiles, two segments were resurveyed with flags placed at 1-meter intervals. These segments were selected because of the appearance on radar profiles of unique reflections from subsurface anomalies. The 1-meter interval enabled a more precise location of the detected, subsurface anomalies.

Pad #3 - Hydrazine Holding Pad

A 1-meter interval was used to construct a 5 x 5 m grid over the proposed hydrazine holding pad area (3 x 3 m). Traverses were made with the 500 Mhz antenna along one side (seaward) of each of the six, 5-m survey lines. These traverses provided 30 meters of continuous, subsurface data.

The radar survey provided a 36 % coverage of the proposed hydrazine holding pad. The survey was conducted with the survey vehicle in a stationary position and the antenna towed by hand at a very-slow walking pace along each survey line.

Following interpretation of the radar profiles, one segment was resurveyed with flags placed at 1-meter intervals. These segments were selected because of the appearance on radar profiles of unique reflections from subsurface anomalies. The 1-meter interval enabled a more precise location of a detected, subsurface anomaly.

Proposed 110 Volt AC Service Lines to Pads #1 and 3:

Two service lines will connect the electrical pad area with the hydrazine holding pad (Pad #3) and the decontamination pad (Pad #1), respectively. The lengths of these service lines will be about 65 meters and 163 meters, respectively. The center lines were located and delineated with survey flags placed at 10-meter intervals. The location of these service lines is not shown in Figure 1.

A traverse was made with the 500 Mhz antenna along each side of the center lines. These traverses provided 456 meters of continuous, subsurface data, and 100% coverage of a 0.60 m corridor. Surveys were conducted by towing the antenna at a very-slow walking pace behind a vehicle housing the radar control and recording units.

Following interpretation of the radar profiles, one 5-meter and three 10-meter segments along the two traverses were resurveyed with flags placed at a 1-meter interval. These segments were selected because of the appearance on radar profiles of unique reflections from subsurface anomalies.

Results

The electrically resistive, sandy soils provided a most favorable environment for the operation of GPR. The 500 Mhz antenna provide adequate depth of penetration (about 2.7 meters) and high resolution of subsurface features. Concerns were expressed over the variable depth to and complex imagery produced by the indurated sands, and the presence of modern cultural features (post-1941) within the survey areas. These features created undesired subsurface reflections which complicated radar interpretations and could have masked reflections from some artifacts (see Figure 2).

The most accepted and efficient method to detect and chart the locations of subsurface anomalies with GPR is to establish grids across survey areas. Several rectangular grids were established across the proposed site of the fuel storage facility at PMRF. Grid intervals varied from 1 to 10 meters. The grid intervals represent a compromise among: purpose of the survey, available time, features being detected, local ground conditions, and desired detection probability.

Table 1 summarizes the radar survey of the proposed fuel storage facility. The survey covered a 4366 m^2 area and provided 3567 meters of continuous subsurface information. Coverage of selected areas ranged from 36 to 100 percent.

All radar profiles were reviewed and interpreted in the field. Two hundred and one point anomalies or reflectors were identified on the radar profiles from the proposed fuel storage area. An "anomaly" is any feature that is dissimilar from the surrounding soil matrix. Twenty-five of these point anomalies were identified as being produced by three buried utility or pipe lines (see "P" in Figure 1). These features produced strong subsurface reflections and formed distinct patterns on sequential radar profiles. These lines were readily identified on radar profiles. Imagery from these features were distinct, occurred at a constant depth, and formed linear patterns on successive survey lines. These features were charted, but were not verified through excavations.

Table 1
SUMMARY OF RADAR SURVEY
OF
THE PROPOSED

			SUBSURFACE ANOMALIES	
	AREA m^2	COVERAGE %	OBSERVED #	VERIFIED #
Asphalt Road	2800	60%	134	15
Pad #1 and access road	545	36%	9	2
Pad #2 and access road	540	36%	15	2
Pad #3	25	36%	4	1
110 v AC service Line	456	100%	39	3

Point anomalies appeared to be concentrated into 5 to 6 fairly distinct clusters (see Figure 1). The clustering was found to be principally related to variations in soil properties.

Twenty-three point anomalies, displaying unique graphic signatures, were selected for further investigations on the basis of depth, signal strength, and reflective pattern. This represents a 13%

sampling of the 176 subsurface anomalies observed on the radar profiles (other than those associated with the utility or pipe lines). The sampling strategy was to detect and identify anomalies suspected of being buried cultural features or artifacts.

At the approximate locations of the selected anomalies, additional, short (<10 m) radar traverse were completed to more precisely define their location and depth. These traverses used a 1-meter interval. Depths to the anomalies were estimated from the radar profiles Anomalies were discerned at each of the selected excavation sites and generally within 1 to 2 inches of the estimated depths.

The excavation of 23 point anomalies identified within the study area revealed no buried cultural features. No artifacts were found in the excavated soil pits. The 23 anomalies were verified as being small pockets of cemented sands (78%), roots (9%), or changes in horizons caused by variations in soil color (9%) and soil texture (4%).

Conclusions

A detailed radar survey within the area proposed for the fuel storage facility at PMRF revealed no major buried cultural feature. Excavations at the sites of twenty-three suspect radar images disclosed no artifacts. Suspected anomalies were identified as being segmented areas of indurated soil materials, plant roots, or buried coral fragments.

With kind regards.

James A. Doolittle

James A. Doolittle
Soil Specialist

cc:
E. Knox, Head, NSSL, NSSC, SCS, Lincoln, NE

FEB 2 4 1992

Interpretations:
Figure 2 is a representative radar profile from a portion of a traverse conducted within the area of the proposed access roadway to the fuel storage facility at PMRF. The two thick horizontal bands (labelled "A") in the upper part of Figure 2 are reflected images from the ground surface. These bands represent one interface, the air/soil interface. The dark bands represent positive and negative signal amplitudes. The intervening, thin white band is the zero or neutral crossing between the positive and negative signal amplitudes.

Below the images of the air/soil interface (A) is a dark band (labelled "B") representing a composite reflection from several closely spaced, surface and near-surface features. These overlapping images are poorly resolved because of the low range and high gain settings used in this survey. These superimposed images are produced by changes in vegetation, surface roughness, soil texture, horizons, and/or moisture within the upper 25 to 40 cm of the soil profile.

Below the surface and near-surface reflections are images from subsurface features. Interfaces are categorized as planar or point reflectors. Soil horizons, water tables, fractures and geologic strata appear as broad and relatively flat reflectors on radar profiles. These features are planar reflectors. Planar reflectors appear as multiple, parallel bands on most graphic profiles. In Figure 2, the contact separating sands from indurated sands and strata within areas of indurated sands (dashed lines) approximate planar reflectors. However, these features are extremely segmented and irregular.

Small objects, such as buried rock fragments, roots, artifacts or utility lines (when crossed perpendicular to their long axis) are point reflectors. These features have restricted dimensions and dielectric properties which contrast with the surrounding soil matrix. Point reflectors generally produce hyperbolic patterns. These patterns are created by the antenna's conical radiation pattern. The antenna "sees" reflections before and after it passes over a subsurface reflector. The hyperbolic pattern results from range changes as the antenna approaches, passes over, and goes beyond subsurface reflectors.

Several point reflectors or anomalies have been identified in Figure 2 (immediately to the left of all "a" symbols). An "anomaly" is any feature that is dissimilar from the surrounding soil matrix. A point anomaly is a feature that, unlike a soil horizon or geologic strata, has very limited lateral extent. The size, shape, and depth to an anomaly affect radar interpretations. In addition, large objects reflect more energy and are easier to detect than small objects.

The presence of scattering bodies in soils can complicate interpretations and adversely affect radar surveys. Stratified soil horizons, layers of cemented or "lithified" sands, roots, and

modern cultural features, produced clutter and undesired reflections which complicated radar interpretations. The radar imagery was complicated by irregular, segmented layers of weakly to strongly cemented sands. These layers appeared on most radar profiles at depths ranging from 0.25 to 2.5 meters. In Figure 2, cemented sands range in depth from about 0.5 (right-hand portion) to 2.0 (left-hand portion) meters. It is possible that these scattering bodies masked the presence of some cultural features which because of the complex imagery, were indistinguishable from the surrounding soil matrix.

In the course of this survey, several point anomalies were distinguished on the basis of depth, signal strength, and reflective pattern. Twenty-three of the best expressed or most suspected point anomalies were excavated. These anomalies represented small pockets of cemented sands (78%), roots (9%), and changes in horizons caused by changes in soil color (9%) or soil texture (4%).

Soils:
The site is located in an area of Jaucas soils. Previous studies (March 1990) demonstrated the effectiveness of using GPR techniques in areas of Gauchos soils on Kauai. The coarse-textured Jaucas soil is a member of the carbonatic, isohyperthermic Typic Ustipsamments family. This excessively drained soil has formed in water-deposited coral sands and is deep (> 1.0 m) over coral. Most soil profiles contained layers of weakly to strongly cemented sand at depths ranging from 0.25 to 2.5 meters.

EDX Fiber Optics Line

A 215-meter center line was established along the passageway for a proposed fiber optics line. Measurements originated near a densely vegetated area which border a drainage ditch and extended 100 meters across an open area. At 100 meters, the line changed direction (to the east) and continued 60 meters to a point near a building complex. The line was extended an additional 50 meters in a irregular direction through and pass the building complex. The center line was also extended 5-meters from its origin into the densely vegetated area.

Additional survey flags were placed in the ground on either side and at a distance of 1 meter from the flagged, center-line positions. This procedure produced a 2 x 215 meter grid along the proposed corridor for the fiber optics line.

Radar traverses were conducted with the 500 Mhz antenna on both sides of the center line and on the interior side (towards the center line) of the other two survey lines. This provided 660 meters of continuous radar data and a 60% coverage of the proposed EDX fiber optics line.

The radar survey revealed 107 subsurface anomalies. Three of these anomalies were selected for excavation. Excavations were conducted in the 0 to 100-m portion of the survey area. The 110 to 210 portion was more disturbed and contained several utility lines and modern features which were believed to be related to nearby the building complex. Excavations at the sites of the three "best-choice" anomalies revealed variations in soil properties or coral fragments occurring at the interpreted depths.

WEEKEND EDITION
FRIDAY - SUNDAY
JAN. 31-FEB. 2, 1992

Serving Paradise in the Pacific

KAUAI TIMES

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WEEKEND REPORT

Money for flood victims

KALAPAKI — Anahola flood victims continue to be the focus of local fund-raising efforts. Hawaiian Airlines and Kauai Lagoons Resort Company teamed up to sponsor a benefit golf tournament last Saturday. More than $12,000 was raised for the American Red Cross Flood Relief fund and will be targeted for Anahola flood victims.

Celeb sports challenge

LIHUE — NFL and Pro-Bowl players will compete with Kauai Police officers at 7:30 p.m. Wednesday, Feb. 5, at Kauai High School in the first annual Celebrity Sports Challenge basketball game.

Proceeds from the event will go to the Hawaii Police Athletic Federation programs, the Troy Barboza Law Enforcement Torch Run for Special Olympics, Kauai D.A.R.E. programs and other organizations. For more information, call 246-2158.

Food, karaoke on tap

KAPAA — A free food fare and the kick-off of the U Can Sing monthly karaoke contest is on tap tonight (Friday) at Kauai Village. Food booths and beer garden will be open from 5 to 9 p.m. and the karaoke contest runds from 6 to 9 p.m. There also will be prize giveaways, special in-store sales and restaurant dining specials.

The U Can Sing karaoke contests will be held every month on center stage by the waterfall at Kauai Village. Contests are open to amateurs only and include three age divisions. Applications are available at the Kauai Village management office or at U Can Sing. Contestants must bring their own tape, but players will be provided. Prizes will be awarded and the first place winner will advance to the finals in December. For more information, call 823-0033.

Free tax workshop

Hawaiian Homes hearing under fire

Trask says folks at home misrepresented

By SUE DIXON-STONG

ANAHOLA — Native Hawaiian leader Mililani Trask has blasted U.S. Sen. Daniel Akaka's office for its role in handling a Senate oversight hearing on the Hawaiian Homes Commission Act. The hearing is scheduled to be held Thursday, Feb. 6, in Washington, D.C.

Speaking at a sovereignty workshop Sunday in Anahola, Trask said location of the hearing as well as short advance notice will make it difficult for the Hawaiian community to testify.

Head of Ka Lahui Hawaii, an 8,000-member Native Hawaiian initiative for self-governance, Trask said the hearing has been planned for at least three months, but the date was not made public until Jan. 22 when a press release was issued by Akaka's office.

SERIOUS IMPACTS: "The hearing has serious impacts and ramifications on our people, and it's being done in a closed manner up in Washington, which is thousands of miles away from the impacted population," she said.

Akaka's communications director Robert Ogawa said a press release issued Dec. 12 mentioned that the hearing was being planned for January or February, but no date was specified.

In a phone conversation from Washington on Tuesday, Kiaaina said she has been calling a lot of Native Hawaiians who are upset about the hearing, trying to allay their concerns.

> ***'Our objectives are not to absolve the state of any of its responsibility. The focus of this hearing is to get the federal government on line.'***
>
> **Esther Kiaaina**
> **Aide to Sen. Akaka**

Esther Kiaaina, a legislative correspondent in Akaka's Washington office, said the hearing was not officially scheduled until Jan. 21, and a press release was issued the following day.

GET FEDS ON LINE: "Our objectives are not to absolve the state of any of its responsibility," she said. "The focus of this hearing is to get the federal government on line."

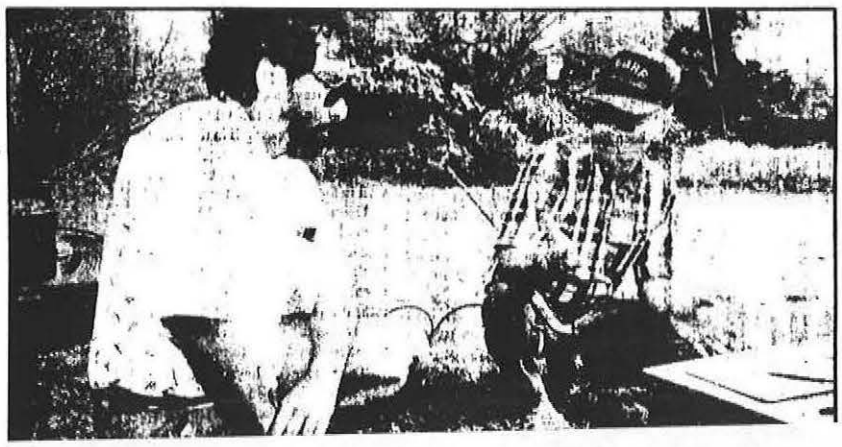
The hearing will be held by the Senate Committee on Energy and Natural Resources, which is a committee that Akaka sits on, but does not chair.

The intent of the hearing is two-fold. First, to define the parameters of the trust responsibility owed to Native Hawaiians by both the federal and state governments in the administration of the Hawaiian Homes Commission Act.

And second, to obtain a full report on the status of the recommendations made by the 1983 Federal-State Task Force on the act. The committee expects to hear testimony on what proposals have been or are in the process of being implemented as well as complete explanations regarding

See HEARING on A-2

High-tech archaeology



Kumon math comes to Kauai schools

By ANNE E. O'MALLEY

KALAHEO — These days, in the face of a national recession and the decline of American industry as we knew it, it's refreshing to hear about something that works and is so terribly simple. It is Kumon math, and it has arrived on Kauai, bringing with it a straight "A" report card from the rest of the world.

Last week, a total of about 45 students at two elementary schools, Kalaheo and Eleele, took the plunge with Kumon math in a two-year, pilot after-school program. Hanalei is next on the list.

District Superintendent Shirley Akita, commenting on the introduction of the

Akaka aide outlines strategy

Senate oversight hearing sparks controversy

HEARING from A-1

those recommendations on which no action has been taken.

Testimony has been requested from U.S. Department of the Interior Secretary Manuel Lujan and U.S. Department of Justice Attorney General William Barr.

State witnesses called to testify are Gov. John Waihee and Hoaliku Drake, head of the state Department of Hawaiian Home Lands. Four public witnesses also have been selected to testify, and Akaka has encouraged written testimony from the public at large.

WITNESS LIST: "We've been getting a lot of inquiries regarding the witness list," Kiaaina said. "We had hoped that individual homestead associations could have been invited, but we do not have final control over who gets invited and how long the witness list is." That control is in the hands of the energy committee.

Public witnesses, who were selected based on their experience with administration of the act, are Alan Murakami, litigations director for the Native Hawaiian Legal Corporation; Ann Nathaniel, former chairwoman of the 1983 task force on the act, Charles Maxwell, Sr., vice-chairman of the Hawaii Advisory Committee to the U.S. Commission on Civil Rights; and Kamaki Kanahele, chairman of the State Council of Hawaiian Homestead Associations.

One of the strategies behind the hearing, Kiaaina said, was to get the Energy Committee more involved with the act. "It seems clear that if the state of Hawaii and the federal government are not going to live up to their obligations, then Congress is going to have to do something about it.

"We saw a need to educate the committee, and a need to get complete understanding of where the act was."

Most people, she said, are aware that the act has been abused. "What people have never done is to have the two parties involved (the state and federal governments) in a hearing room to update everyone on what they have done."

ADVERSE PUBLICITY: Trask suggested that recent adverse publicity surrounding the act has prompted the hearing.

Mililani Trask

Sen. Daniel Akaka

In early December, the Hawaii Advisory Committee to the U.S. Commission on Civil Rights issued a report criticizing the state and federal governments for their failure to properly administer the Hawaiian Homelands Program.

Prior to that, the *Wall Street Journal* published a stinging front page story exposing nationwide many abuses of the act.

"The state and federal governments are very worried that somebody is going to file a civil rights action against them, and they are trying to make a record to show that the state has settled Hawaiian Home and ceded land claims," Trask said.

Kiaaina said Akaka's concern's were triggered well before the *Wall Street Journal* article was published or the civil rights report was released.

The senator's concerns, she said, were triggered by a pattern developing in the Bush Administration, which appears to be an attempt to absolve itself of any responsibility to the act.

> ***'The state and federal governments are very worred that somebody is going to file a civil rights action against them.'***
>
> **Mililani Trask**

"I don't want people to get the idea that we're letting the state off the hook," she said. "The key words are trust responsibility."

NO WAY TO LOSE: No legislation will be introduced to the committee, Kiaaina said. "It is an oversight hearing. There is no way people could lose out of this hearing."

Trask urged people to submit testimony calling for hearings to be held on Hawaii, for extension of the time period for receipt of testimony and for copies of the record to be immediately sent to Hawaii and then copied for the Hawaiian community.

Kiaaina said the energy committee will be asked to expedite distribution of the results of the hearing. "People are going to be able to read exactly what the state and federal governments have said regarding the task force report."

Congress, she said, needs to reevaluate its strategy on helping the beneficiaries of the act. "They're going to have to figure out a way of dealing with it because it can't go on anymore."

Written testimony may be sent to: Committee on Energy and Natural Resources, U.S. Senate, Washington, D.C. 20510. Attention: Allen Stayman.

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PMRF archaeological survey aided by use of radar device

UNDERGROUND from A-1

the Department of Land and Natural Resources.

The survey is being done in cooperation with the U.S. Department of Agriculture Soil Conservation Service, which has sent a soil specialist, James Doolittle, to scan the fuel storage facility site with ground-penetrating radar (GPR) equipment.

Doolittle demonstrated the equipment last week on a site adjacent to the STARS launch pad where a WWII target pit is known to have been buried.

When GPR was developed in the 1930s, Doolittle said, the impetus was military tunnel detection, making it possible to scan through the ground and detect enemy tunnels. Commercial application of the radar technology came into play in the mid-1970s.

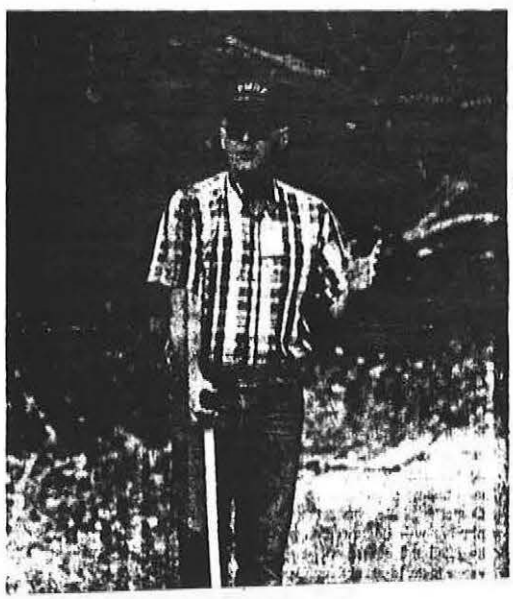
"What it provides," he said, "is an instantaneous chart of the subsurface, similar to opening a trench, but you don't destroy it (the terrain). The beauty of using the radar for archaeological investigations and site where the clusters are."

The GPR, he said, significantly increases the odds of finding something and reduces the necessity for doing blind tests.

One of the problems, however, is that the GPR is interpreter-dependent. "The longer you work with it," Doolittle said, "the better your interpretations become."

The soil specialist said he has been using the equipment for 10 years, having done work in 45 states and three foreign countries.

Doolittle said the GPR is site specific and works well in the sandy soils found along the coastal fringes of the Hawaiian Islands, but not as well in the clay soils of the interior.

Using the GPR, Doolittle has been able to scan 65 percent of the area under investigation in a relatively short period of time. With traditional archaeological techniques, he said, the process would take much longer and the required excavations would be very destructive to the land.

Though the results of the soil survey will be included in the STARS EIS