

Living on the Ocean Floor

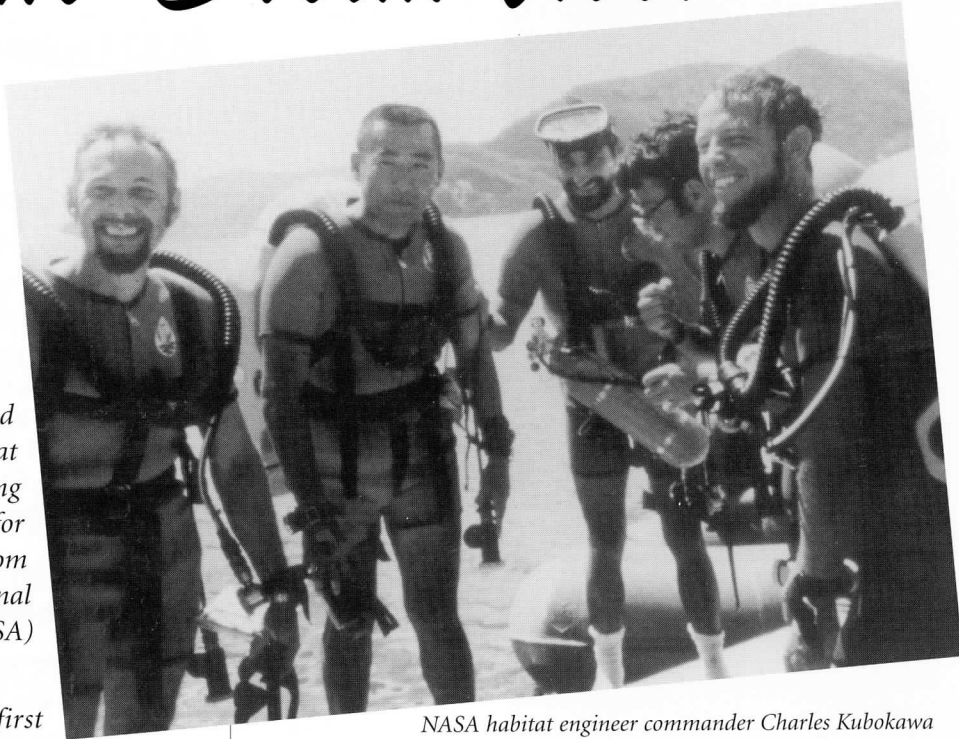
Based on the reminiscences of
Charles Kubokawa,
NASA's first
official aquanaut

Charles Chiharu Kubokawa was born and raised in San Francisco and interned at Tanforan and at Topaz, UT, during WWII. He served in the U.S. Air Force for 5 1/2 years as a flying officer. He graduated from UCLA in 1957 and worked for the National Aeronautics and Space Administration (NASA) from 1963 to 1989.

Last May Kubokawa became the first Japanese American to be inducted into the National Space Foundation's Space Technology Hall of Fame, as the co-inventor of Temper Foam, a highly resilient material developed at NASA Ames Research Center in the 1970s. "I was trying to develop seating for aerospace vehicles so that people could better survive crashes or impacts. We found that Temper Foam in combination with a special seat structure was good for 36 gs (36 times the force of gravity). The seat can out-survive the aircraft in a crash," Kubokawa declares. The nonflammable, nontoxic foam is used in space shuttle seats as well as in commercial products like orthopedic seats, football helmets, special car seats, earplugs, and bed mattresses.

The article below describes another highlight of his career – he was the first official NASA aquanaut.

The Purpose of the Mission. In the late 1960s, NASA began development of Skylab, a manned space station which would circle the earth in permanent orbit. Needing to test equipment, food preferences, crew complement and procedures in conditions similar to those that might be encountered on long-term space missions, an undersea habitat replicating Skylab in size and shape was created by NASA in collaboration with the Department of the Interior, General Electric and the U.S. Navy. In 1970, Tektite II was placed 52 feet underwater in a remote corner of beautiful Great Lameshur Bay of St. John Island in the U. S. Virgin Islands. The project's primary mission was to gather data on operations, living conditions and interpersonal relations in cramped

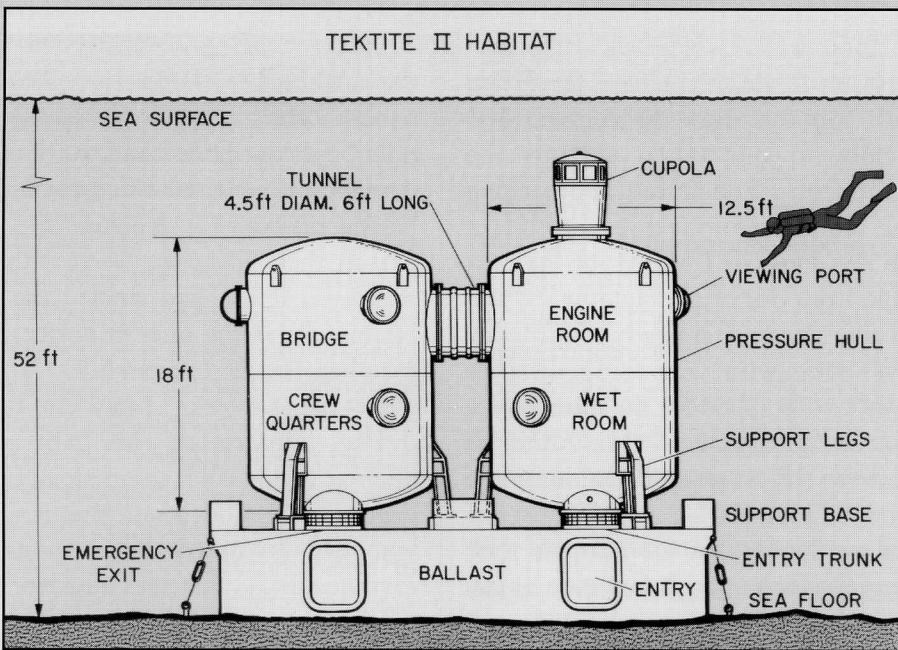


NASA habitat engineer commander Charles Kubokawa (2nd from left) with crew members (l-r) Dr. Ed Clifton, (US Geological Survey); Ian Kobic (Virgin Islands); Dr. Ralph Hunter (USGS) and Jan Vanderwalker (Dept. of Interior) at the start of the Tektite II mission, April 17, 1970. Project Tektite II photo courtesy of Charles Kubokawa.

quarters surrounded by a hostile environment. A practical understanding of these factors was crucial to long term space missions in order to plan for optimal crew motivation, morale and efficiency. Results from the Tektite project guided strategies for future lunar and space missions.

The Habitat. The five crew members were shoehorned into cramped quarters amounting to about 500 sq. ft. The structure consisted of two cylinders each 12-1/2 feet wide and 18 feet tall with two rooms in each cylinder. (See next pg.)

Living in a Hostile Environment. Although 52 feet underwater doesn't seem far compared to a trip into outer space, leaving the undersea domicile and returning to the surface on a whim was an impossibility. The atmospheric pressure inside the habitat was two-and-half times that of sea level and required a special nitrogen-rich breathing mixture. If a crew member were to return to the surface without a 20.5 hour decompression process, the oxygen and nitrogen in his bloodstream would have quickly formed bubbles, causing the bends, embolism and certain death. In space an astronaut would experience similar problems if exiting a pressurized space vehicle into the vacuum of space without the proper pressurized life support system.



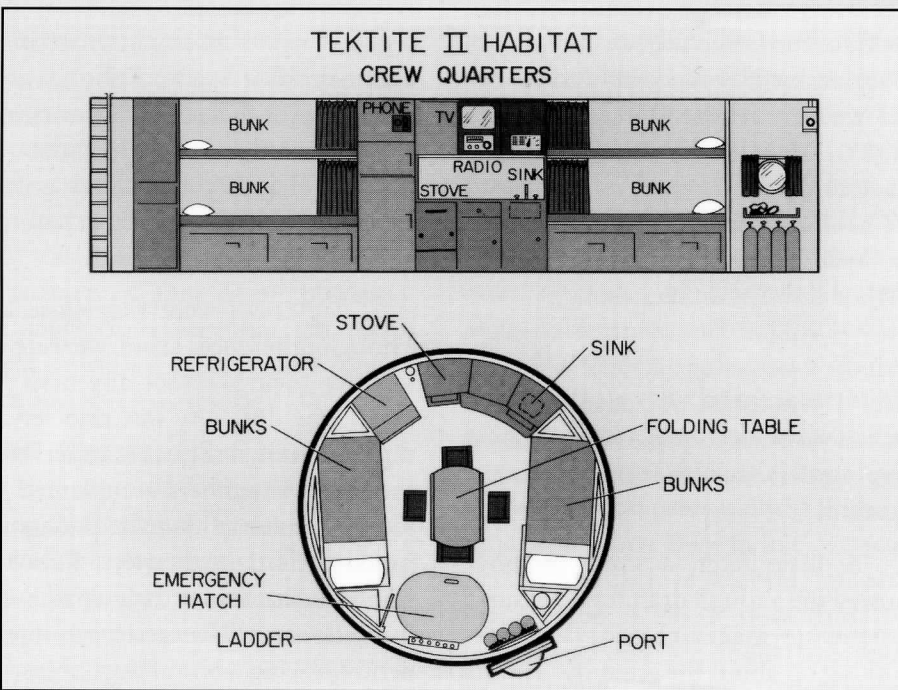
Above: Exterior View of the Tektite II habitat. During the 60-day mission, three different four-man scientific crews each lived in the habitat for 20 days. As commander, however, Kubokawa was assigned for 30 days – half the length of the mission. He spent much of his time in the **Bridge**, the operational center of the habitat, which contained critical sensors monitoring the habitat's life-support systems, the audio-visual communication system, and a laboratory, as well as a fold-out bunk where Kubokawa slept. The right cylinder housed the **Engine Room**, which contained the environmental control system, the air-filtering system, the main power circuit breakers, the food freezer, sink and toilet. Everything passing into or out of the habitat went through the **Wet Room**, where the **Entry Trunk** was located. The crew stored their diving equipment here, logged in supplies, showered and washed their clothes. The four scientist crew members ate and slept in the **Crew Quarters** (below). Ladders provided access between rooms, and the two upper rooms were connected by a tunnel. In each room a 24-hour audio-video monitoring system recorded the aquanauts' movements and behavior, enabling researchers in the Surface Control Van to track time expended on specific activities, preferences for various locations, and modifications made to furniture and equipment to alter living conditions. In the event of malfunctions in the life-support system, each room also contained emergency oxygen sources. Habitat drawings: NASA, Ames Research Center, Moffett Field, CA, courtesy of Charles Kubokawa.

Kubokawa recalls that a wooden broom chillingly illustrated the destructive power of sudden depressurization. "On the first day of our mission we happened to find a broom left by the cleanup crew. Having a vacuum cleaner, we didn't need it, so a crew member floated it out of the entry trunk. Once it reached the surface, the broom handle started to fizz like seltzer and exploded into many fine shreds of wood."

The Daily Routine. Existence within the hostile environment complicated many routine tasks. Supply transfers via pressure-controlled canisters consumed an entire day every week, as well as the combined efforts of the entire underwater crew and several support divers from the surface. Even something as mundane as using the "head" (toilet) posed difficulties when the commode's machiolator (grinder) malfunctioned. The crew had to resort to various complicated methods of disposing of human waste for what felt like a very long week before the support team was able to locate and purchase a replacement part from Hong Kong.

Research Projects. In addition to their "housekeeping" duties, the crew made one to three daily underwater explorations outside the habitat. Designed to simulate the EVA (extravehicular activities) operations of future space missions, the undersea excursions enabled the crew to gather scientific data on the marine environment, including the oxygen content of sea water under pressure, movements of marine organisms, identification of previously undiscovered marine species, and the effects of pollution on coral reefs.

Kubokawa (con't on next page)



Kubokawa (con't from p. 5)

The crew relied on rebreather systems which had been newly developed by NASA and the U.S. Navy for use in space and modified for aquatic use. Unlike the compressed air tanks used for SCUBA diving, which had limited capacity, the rebreather system provided oxygen for a much longer period by scrubbing carbon dioxide out of the diver's exhaled breath and regenerating it into rebreathable air. In tests of the equipment, Kubokawa and a colleague established a mission record, using the apparatus for almost six hours.

Hazards of the Sea. Kubokawa recalls several incidents which brought home the dangers of the mission. "When divers get immersed in what they're doing without awareness of their surroundings, hazardous conditions can easily occur. Two of us were taking data on a coral reef 65 feet below the surface. Unbeknownst to either of us, a large support freighter assigned to our project was approaching our position. A dark shadow was cast on our research area, as if someone had turned off the room lights. We looked up to see the bow of the ship closing in on us, while the propellers churned at high speed less than 10 feet above our heads. Knowing that we could get sucked in by the currents created by the propellers, we dove deeper as quickly as we could. And none too soon! One of our clipboards was sucked in by the propeller currents and chewed into pieces.

"Another time, two of us dove with pressurized oxygen tanks rather than with rebreathers. We ran low on oxygen while conducting research. We activated our pinger to request an air resupply from the support team. When they did not respond within the allotted 3 minutes, we contemplated our lose-lose situation: our air tanks might

run out or we might have to surface with minimal time to depressurize. Finally, to our relief, we saw the bottom of a Zodiac raft approaching us. I motioned for my dive mate to take the first tank. As I waited for the next tank, I ran out of air. Holding my last breath, I swam frantically towards my dive mate who was some distance away, and grabbed for his mouthpiece to get some much needed air. Although we were able to share the mouthpiece for awhile until my air tank arrived, I was not happy that the resupply took longer than the established time limits. When we returned to the habitat I communicated forcefully to surface control that their tardiness had almost cost us our lives."

Earthquake? "On another outing, a fellow aquanaut and I experienced a very loud explosion and a shock wave that caused the fish, the underwater vegetation and us to move from side to side in unison. It was an odd sensation, like being jiggled in a huge bowl of jello. The noise was loud enough for me to wonder if the habitat had exploded. As the commander I was responsible for the habitat and crew; I had to make sure everyone was all right. We swam back to the structure as fast as we could. As we ascended the underwater reef we were relieved to see the white habitat, structurally intact. After I made sure that there was no damage to the habitat or crew, I announced that we had experienced an underwater earthquake. The others thought I was crazy until surface control checked with the emergency network in Puerto Rico. I was right. A magnitude 4.1 Richter Scale earthquake had occurred deep underwater, centered near our location.

"A little later, a crew member showed me a rough draft for a *National Geographic* magazine story he was working on about the scientific aspects of Tektite II. He had written that after

the earthquake, I had returned to the habitat "green with fright" and that other crew members had to calm me down. I was incensed. I told the author he was off base for depicting me as a person that fell apart. Deep within I wondered if he had singled me out because I was the only minority crew member. Did he purposefully want to depict me as inferior? I told him that I did not appreciate his fabricated attempt to add color to his story at my expense. I reminded him that it was I who had identified the event as an earthquake and that, as a native of San Francisco, I had weathered much more severe earthquakes. He apologized, retracted the discriminatory story and admitted he had done it at my expense."

The Sole Minority Crew Member. The incident was particularly galling to Kubokawa because he was working close to 21 hours a day to ensure that crew performance excelled. "I was the first minority person to serve in a major NASA program. This awareness inspired me to work even harder, doing more than what was required of me because whatever I did, good or bad, reflected on my family and on the *Nikkei* community." In addition to his regular research, maintenance and administrative work, Kubokawa frequently went the extra mile, encouraging crew morale with small but thoughtful gestures such as greeting returning divers with hot beverages and helping them unload.

"The crews were very close knit. Though differences arose, we were able to solve them without any hard feelings." One difficulty was resolved in a diplomatically indirect manner. When three crew members complained that the body odor of their bunkmate pervaded their tight quarters, Kubokawa resolved the issue with a non-confrontational *Nikkei* gesture – prominently placing a bar of deodorant soap on the offending party's bunk. The

soap was promptly used, and olfactory ambience was restored. "After that, I always made sure there was deodorant soap in the shower," added Kubokawa.

Space Food. The crew served as guinea pigs for food that might be served in space. Prepared under direction of the NASA medical office, meals and snacks were carefully balanced for nutritional value and doled out in a rigid ten-day rotation. No personal food was permitted because the crew would be subjected to a controlled physical analysis at the end of the mission. Asked to evaluate the menus for taste and preference, some of the crew demonstrated their preference in unforeseen ways. They fed unwanted leftovers to a huge red snapper which made daily appearances at the entry trunk around 9:30 am for a handout. The gigantic fish seemed to prefer French toast and sausage links, but never refused anything edible. Other crew members filched the "good" meals from food supplies intended for a later crew. Kubokawa did a little "cheating" of his own by smuggling in a small bottle of Kikkoman soy sauce to enliven the bland frozen meals. After he shared his contraband with the others (three of whom had never tasted *shoyu* before), the bottle disappeared. Although the empty bottle turned up later, Kubokawa was never able to discover who had used it up. "A month without any rice or *Nihon shoku* (Japanese food) was a low point of the mission," he commented. One of his post-mission suggestions was that the menu should be varied by including foreign foods and spicy seasonings.

Cultural Diversity. Kubokawa felt that the diversity of cultural heritage among the personnel provided opportunities for learning and teaching about language, mannerisms, food perceptions, and customs. He suggested that diversity on future long-term

missions would enrich the crew's leisure hours.

At the end of the mission, Kubokawa had a dream in which his late father and his brother appeared to tell him that his extra efforts on the mission had made his family and the *Nikkei* community proud.

"I grew up with the sense that it was up to me to carry on the work ethics and traditions instilled in me by my parents and by the *Nikkei* community. During the mission I did my best

As the first minority person to be selected for a major NASA program, I did my best... knowing that by excelling, I could help pave the way for future generations of *Nikkei*.

to embody the loyalty, dedication, worth, dependability and productivity they taught me, knowing that by excelling, I could help pave the way for future generations of *Nikkei*."

A Priceless Experience. "The entire underwater experience was a priceless highlight of my life," he recalls. "Every day was unique. I developed a greater appreciation of the unseen underwater world. When we dove with conventional SCUBA gear, the noise of exhaled air frightened off the fish, but when we used the silent rebreather systems, schools of fish would swim along with us. At night large schools of fish came to visit our habitat and some warmed their tails in the heat of the exterior light. The fish became our companions and friends. They would show up almost every night at the same time, and when they didn't, we worried. I used to love seafood, but after the mission, I shied away from my favorite *sashimi* for about five years. Eating fish felt like eating a pet.

"Our daily excursions underwater left us with an increased awareness of the fragility of the underwater ecosystem. Even in a remote area like Lameshur Bay, every day we returned to the habitat with huge garbage bags full of litter picked off the ocean floor – glass and plastic bottles, metal cans and other non-biodegradables which had been casually dumped by generations of pleasure craft anchored in the secluded bay. The garbage was sent 'topside' for proper disposal. We were particularly careful to pick up plastic bags because when caught on the coral reefs, they suffocated and killed the live coral. In areas untouched by humans the pristine underwater environment is truly beautiful and we did our part to keep it that way."

Almost Home? At the end of his shift, Kubokawa sent up his belongings and was preparing to surface when Surface Control notified him that he would have to remain underwater for another 30 days. His replacement, another NASA aquanaut, had collapsed from anxiety prior to entering the water alone to swim to the habitat. Although the mission controllers were apprehensive about Kubokawa's reaction to the unexpected extra duty, he took the news in stride. "At first I thought it was a joke. I said, 'OK, send my belongings down!' When my gear was returned to the habitat, I realized they were serious. I really didn't mind because I thoroughly enjoyed the beauty of the quiet marine world that existed below the surface. By the next day, my replacement calmed down and was able to take up his shift. I learned later, that he stuck to the habitat for his whole shift and never ventured out on underwater excursions.

"For me the daily explorations were adventures that I looked forward

Mrs. Sasaki and Mrs. Nakahashi were there. And he called them 'obaasan' [grandmother]. They were happy he remembered them.... I was so happy he remembered the older people. He spoke simple Japanese language to them. The ladies were so happy he remembered them."

In the wake of the Challenger explosion and the end of Ellison's life, he is remembered more for what he was than what he accomplished as an astronaut. The enduring memories are of his qualities as a son, father, husband and friend, rather than his technical feats and space exploration. In turn, Ellison's human qualities reflect the pervasive influence of his family and community life in rural Kona. This connection between the humanity of Ellison and his roots in Kona is a recurrent theme in the memorial tributes.

The then-Governor of Hawai'i, George Ariyoshi, who shared many intimate moments with Ellison during his trips home, said of him: "What impressed me most about Ellison was how he went to NASA a country boy and how he remained a country boy. And I mean country boy in the very finest sense. All the values of the community were instilled in Ellison: down-to-earth, a feeling of respect for people where everyone knows everyone else and cares about each other. It was something Ellison communicated. He never lost his country roots."

Ellison Onizuka was part of the *Challenger* crew called the "All American Dream Team" composed of civilian and military personnel, five men and two women, including an African American, an Asian American, Protestants, Catholics, a Buddhist and a Jew. They represented the very best that America could produce. But in Hawai'i, Ellison Onizuka is remem-

bered as the Kona boy who dreamed of the stars and made his dream come true. A memorial tribute to Ellison Onizuka reads, in part:

"He left us also the legacy of his dream. In his dream begin our responsibilities.

"He believed in a world where every creature would fulfill their potential by looking beyond their limitations. He taught the children to make themselves and their communities a better place in which to live. He envisioned other worlds and adventures so that we could make this earth a more tolerable and peaceful speck of dust in the universe. His dreams must not only survive in the monuments we erect or the honors we bestow. It is our responsibility, each in our own private way, to strive to fulfill our destiny with strength, kindness, humility and honor." ■

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**ASTRONAUT
ELLISON S. ONIZUKA
SPACE CENTER**

is located at the Keahole-Kona International Airport, Kailua-Kona, Hawai'i. The non-profit facility is committed to keeping the memory, dreams and accomplishments of Hawai'i's first astronaut alive, particularly by reaching out to children. The Space Center contains 4,000 sq. ft. of space-related exhibits, interactive displays, video theater and gift shop.

\$2 adults/ 50¢ children

Open 8:30am-4:30pm daily
(except Thanksgiving, Christmas, New Year's)

**More info: Onizuka Memorial Committee
PO Box 833, Kailua-Kona, HI 96745
(808)329-3441**

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son. Aside from a couple of incidents where kids made fun of me, there was no discrimination or harassment. I didn't feel in any way a minority in my community.

"What it means to be Japanese American is a hard question for me to answer. I know I really benefit from being a citizen of such a tremendous and privileged country. And I know that my parents were heavily influenced by their Japanese experience and that certain values and morals and ethics were passed on to me by my parents. It's hard for me to separate the privileges of being an American citizen from the privileges or qualities I've received from my parents. In other words, I don't know whether my mom is a fantastic person because she is Japanese or just because she's a fantastic person.

"It is amazing that my parents were interned by their own country and that this same country may soon send their son into space. It's a testament both to the strengths and qualities I got from my parents and to the opportunities that are available to me as an American citizen." ■

to and that I made time for in between my assigned duties. The undersea world was truly a paradise in another dimension that could never be replicated by any other means." ■

"Living on the Ocean Floor" was based on a manuscript which Mr. Kubokawa wrote for NJAHS at the urging of Mas Yamasaki. The original 23-page document is in the NJAHS Archives. Mr. Kubokawa has been active in the Nikkei community for many years. He received a Japanese American of the Biennium Award from the JAACL in 1974, founded PANA (Pan American Nikkei Association), and chaired the 1993 Topaz Pilgrimage and the 1998 Topaz reunion. He has also been active in the United Way and the American Red Cross.