CULTURAL SIGNIFICANCE OF MAUNA KEA

Sacredness of Mauna Kea

ʻO Mauna Kea ko kākou kuahiwi laʻa (Mauna Kea our sacred mountain) expresses the feelings that modern day Hawaiians and non-Hawaiians alike have for this wahi pana, or legendary place. As with other cultures throughout the world, early Polynesians believed their highest points of land were the most sacred.

Of the four major islands in the Hawaiian group, tradition tells us that the highest and most sacred places were Mauna Waiʻaleʻale on Kauaʻi; Mauna Kaʻala on Oʻahu; Mauna Haleakalā on Maui; and Mauna Kea on Hawaiʻi. Mauna Kea, being the highest point throughout Pacific Polynesia, has been considered by many Hawaiian practitioners to be the most sacred of all. Standing tall over the island of Hawaiʻi, Mauna Kea was host to early Hawaiian traditions that included, among other things, religious practices, study of the heavens, and tool making in the Keanakākoʻi Adze Quarry.

The Highest Portal to the Hawaiian Universe

Mauna Kea is the mountain altar of Wākea, also known as the celestial father. Wākea is the sire of the indigenous Hawaiian race. The tallest mountain in the world, Mauna Kea is the highest portal to the Hawaiian Universe, and is therefore the pillar of native consciousness. Additionally, Mauna Kea is a Koʻa, the magnet through which all life flows. Like the fishing koʻa (traditional fishing grounds), koʻa Mauna (mountain koʻa) are shrines that are fed and maintained over many generations to ensure that the links to all life are not threatened.

A Sacred Spiritual Burial Ground

Many traditional Hawaiian eulogies speak to the "hoʻi i Ka-houpo-o-kāne," or returning into the heart of Kāne. Mauna Kea contains burials of the most sacred chiefs, known as the descendants of Wākea and Papahānaumoku - who gave birth to the islands. It is believed that Mauna Kea is where some of the spirits of the deceased returned. Specifically, Kahoupookāne, a female spring and rivulet, is the spirit entrance into the mountain's energy. Mauna Kea is known as the piko (umbilical connection to the Universe) of Hawaiʻi. Even today, many families continue to bury the umbilical cords of their children on the mountain as a way of certifying indigenous birth. Family shrines are also established on the mountain to serve as a portal for direct spiritual communication with Wākea.

The Source of Life

Mauna Kea makes up a large part of the island's aquifer; it is believed that Poliʻahu (snow), Lilinoe (mist) and Waiau (ice) are the female waters in perpetual intercourse with Wākea for the furtherance of all life.

Archeological Sites Found on Mauna Kea

There are hundreds of archaeological sites (e.g., traditional cultural properties, shrines, burials and culturally significant landscape features) within the summit area of Mauna Kea. The State of Hawaii Historic Preservation Division has designated three areas as traditional cultural properties (TCPs): the summit (Kūkahauʻula) and Puʻu Lilinoe in the MKSR and Lake Waiau in the Mauna Kea Ice Age Natural Area Reserve. A large area on the summit of Mauna Kea has been determined to be eligible for listing on the National Register of Historic Places as a historic district.

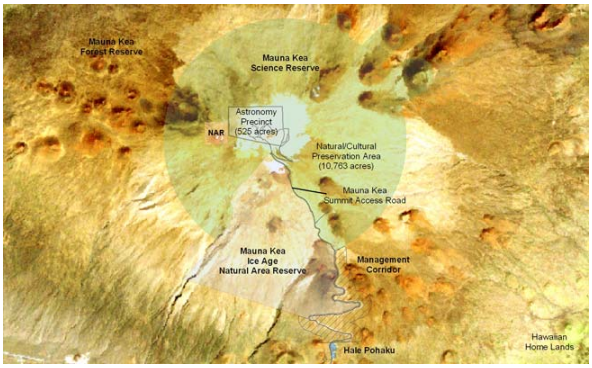
Keanakāko‘i Adze Quarry

Concentrated between 11,000 and 12,500 feet within the Mauna Kea Ice Age Natural Area Reserve is an area of very fine-grained, dense basalt rock formed when lava erupted and flowed beneath the glacial ice caps. These unique rock outcrops were discovered by Hawaiians and quarried for use in the manufacture of adzes (*ko‘i*), traditional stone implements used for chopping and carving wood. Keanakāko‘i is the single largest basalt quarry area in all of Polynesia. The complex also contains shrines, trails, rock shelters and petroglyphs. The Adze Quarry was placed on the National Register of Historic Places in 1962 as a National Historic Landmark.

JURISDICTIONAL RESPONSIBILITIES ON MAUNA KEA

Conservation Lands

The lands of Mauna Kea from about 6,000 feet to the summit are classified as ‘conservation district’ *(Hawai‘i Revised Statutes (HRS) §205-2)*. The Department of Land and Natural Resources (DLNR) through the State Office of Conservation and Coastal Lands has the authority to regulate and enforce the uses of conservation district lands *(HRS §183C-3)*. Within the conservation district, DLNR has established five subzones: protective, limited, resource, general, or special *(Hawai‘i Administrative Rules (HAR) §13-5-10)*. The Mauna Kea Science Reserve (MKSR) lands fall within the purview of these resource subzones *(HAR §13-5-13)*.



Credit: SRGII

Lease of conservation lands between BLNR and University of Hawai‘i

In 1968, the BLNR approved a 65-year lease (from January 1, 1968 to December 31, 2033) to the University of Hawai‘i (UH) *(General Lease No. S-4191)* for an area comprising approximately all lands above 12,000 feet. The leased area, known as the Mauna Kea Science Reserve (MKSR), is an approximately circular area (2.5 miles in radius, centered on the UH 2.2m telescope near the summit), except for those areas that were withdrawn and designated as part of the Mauna Kea Ice Age Natural Area Reserve (NAR) in 1981. The boundary on the northeast side of the MKSR has three lobes that extend further down the mountain to include Pu‘u Makanaka and two other large cinder cones.

Presently, the area of the MKSR is 11,288 acres, of which 10,763 acres has been designated a Natural/Cultural Preservation Area and 525 acres as an Astronomy Precinct. (*2000 Master Plan*). The lease identified the “specified use” as “a scientific complex, including without limitation thereof an observatory, and a scientific reserve being more specifically a buffer zone to prevent the intrusion of activities inimical to said scientific complex.”

Leased lands also include a 19.3-acre parcel (Lease No. S-5529) at Hale Pōhaku. The facilities at Hale Pōhaku include the Onizuka Center for International Astronomy (OCIA) (mid-elevation support facilities), the Visitor Information Station (VIS), and an old construction laborer camp.

Some of the cabins in the old camp are now used by the OMKM rangers, VIS staff, volunteers, and researchers.

Subleases Between University of Hawai'i and Telescopes Facilities

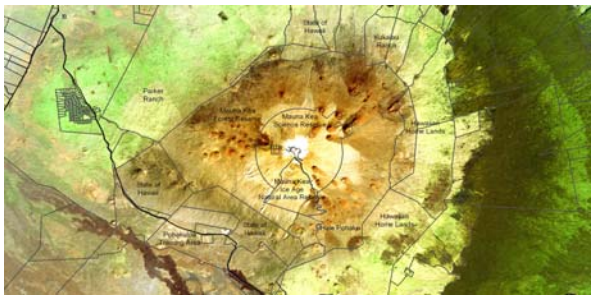
UH subleases portions of the MKSR to telescope facilities, except for those that are considered part of UH (UH 0.6m telescope, UH 2.2m telescope). Conservation District Use Permits are required for each facility.

DLNR Forest Reserve

The DLNR Mauna Kea Forest Reserve lands encompass approximately 52,500 acres above 7,000 ft elevation up to the MKSR boundary. The forest reserve contains mamane forest, habitat for the endangered palila bird. Hunting is allowed in accordance with DLNR regulations (Title 13, Chapter 123). The forest reserve is under the jurisdiction of the Department of Land and Natural Resources, Division of Forestry and Wildlife.

Natural Area Reserve

The Mauna Kea Ice Age Natural Area Reserve (NAR) is comprised of two parcels surrounded by and adjacent to the MKSR. A 143.5-acre square parcel around Pu'u Pohaku, is located to the west of the summit area. Fossil ice left behind by glaciers has been found within in its boundaries. The larger 3,750-acre triangular shaped parcel extends from approximately 10,070 feet up to 13,230 feet at the tip of the parcel. Within this larger area are several unique features: Lake Waiau, the only high-elevation alpine lake in the state; the Mauna Kea Adze Quarry; and geomorphic features created by glaciers such as moraines, and glacial till. The NAR area is under the jurisdiction of the Department of Land and Natural Resources, Natural Area Reserves Commission.



Credit: SRGII

Department of Hawaiian Home Lands

The Department of Hawaiian Home Lands has jurisdiction over approximately 53,000 acres of the lands of Humuula Mauka that were designated by the Hawaiian Homes Commission Act of 1920 to be made available for homesteading purposes. This land was held under leases by Parker Ranch from 1914 to 2002. Today, limited ranching of cattle continues on Humu'ula, under a permit issued by the DHHL. DHHL is currently working, along with beneficiaries and applicants for pastoral lease lands, on a plan for land stewardship and lessee opportunities on Humu'ula lands near the junction of Saddle Road and the MK Observatory Access Road.

Pōhakuloa Training Area

Pōhakuloa Training Area (PTA) is located in the saddle area between Mauna Loa and Mauna Kea. Totaling 108,792 acres, PTA extends up the lower slopes of Mauna Kea to approximately 6,800 feet in elevation and to about 9,000 feet on Mauna Loa. PTA lands are within the conservation district general, limited, and resource subzones. As the largest military training area in Hawaii, PTA is used for nearly all of the diverse types of training conducted by the armed forces and includes impact areas, firing ranges, an airfield, and maneuver areas.

MANAGEMENT OF THE MAUNA KEA SCIENCE RESERVE

Office of Mauna Kea Management

The Office of the Mauna Kea Management (OMKM) is charged with the day-to-day management of the Mauna Kea Science Reserve as prescribed in the 2000 Master Plan. OMKM works closely with the Mauna Kea Management Board (MKMB) and the Kahu Kū Mauna Council and several advisory committees. The Mauna Kea Management Board (MKMB) is composed of seven members of the community who are nominated by the UH Hilo Chancellor and approved by the UH Board of Regents. The MKMB guides the operations of OMKM and advises the Chancellor on activities, operations and development. Kahu Kū Mauna (Guardians of the Mountain), a nine-member council named by the MKMB, advises the MKMB, OMKM and the UH Hilo Chancellor on Hawaiian cultural matters. Other advisory councils include the MKMB Environment Committee, formed to advise the MKMB on environmental issues; the MKMB Hawaiian Culture Committee; the Astronomy Education Committee; the Public Safety and Conduct Committee; and the Wēkiu Bug Scientific Committee.

Rangers

OMKM manages a ranger program to facilitate visitor safety and education on Mauna Kea. Rangers advise visitors of weather conditions and potential hazards associated with ascending the mountain (e.g. altitude sickness, road conditions). They recommend approaches to safely visiting Mauna Kea and provide emergency assistance when necessary. Educational responsibilities are an important component of the rangers' daily activities. They distribute the safety brochure, provide information on the unique natural and cultural resources, identify the various observatories, direct visitors to established hiking trails, and educate visitors on prohibited or destructive activities. Rangers perform site maintenance activities, including coordination of litter removal ("an ever-present responsibility") and trail maintenance. Daily patrols document the activities of the general public, observatory personnel, and commercial tour operators. Rangers also assist OMKM with compliance matters, including semi-annual inspections of all observatories for compliance with their respective conservation district use permits and compliance with the conditions imposed by the MKMB on specific projects.

Mauna Kea Observatories Support Services

The Mauna Kea Observatories Support Services (MKOSS) is responsible for providing support to the observatory facilities, managing the facilities at Hale Pōhaku; maintaining the summit access road, including road and snow removal; providing utility support, and safety and emergency services; and maintaining the communication network. MKOSS also manages the Visitor Information Station.

Management and Master Plans for Mauna Kea

Management of the MKSR is pursuant to the policies set forth in the General Lease S-4191 between BLNR (lessor) and UH (lessee), the DLNR Administrative Rules Title 13, and the conditions imposed by BLNR on various conservation district use permits.

A series of plans have been prepared for Mauna Kea since the 1970s, including development plans, master plans and management plans. The *1977 DLNR Mauna Kea Plan* was developed to serve as "a policy framework for the management of Mauna Kea". This plan was superceded by the *1985*

University of Hawai'i Mauna Kea Management Plan and, later, by the *1995 Revised Management Plan for the UH Management Areas on Mauna Kea*, the current BLNR-approved plan for Mauna Kea. These management plans were designed to assign management and enforcement responsibilities for public and commercial use and institute commercial use and management controls for the area.

The *2000 Mauna Kea Science Reserve Master Plan* was adopted by the UH Board of Regents as the policy framework for the responsible stewardship and use of university-managed lands on Mauna Kea. The master plan created a new management structure, housed within the University of Hawai'i at Hilo as the local management authority over Mauna Kea. The master plan also delineated an astronomy precinct, which confines astronomy development to 525 acres within the MKSR.

Year	Description of Management Plan	Approved by
1977	*Mauna Kea Plan.* Adopted by DLNR to serve as policy framework for the management of Mauna Kea. The plan divided Mauna Kea into five management areas and described acceptable uses and management controls for each area. (1998 audit report).	BLNR
1980	*Hale Pōhaku Master Plan.* Prepared by DLNR to address the mid-level facility at Hale Pōhaku. Served as a guide to UH in the design and construction of the astronomy mid-level facility. The plan incorporated the needs of the six telescopes in the operation at that time, allocated space for public restoration and set controls for future expansion. (1998 audit report).	
1982	*Research Development Plan (RDP) for the Mauna Kea Science Reserve and Related Facilities.* UH approved the RDP as its own research development plan for the Mauna Kea Science Reserve and Hale Pōhaku facilities. The RDP was to serve as a programmatic master plan for the continued development of the Mauna Kea Science Reserve.	UH Board of Regents
1983	*Mauna Kea Science Reserve Complex Development Plan.* UH developed this plan to facilitate the implementation of the specific research facilities identified in the plan. The plan consisted of two components. The first component was a complex development plan to provide the physical planning framework to implement the UH Research Development Plan. The objective of the document was to guide and control development in order to preserve the scientific, physical, and environmental integrity of the mountain. The second component was the environmental impact statement to evaluate the general impact of implementing the actions proposed in the complex development plan and propose mitigating actions for potential negative impacts. (1998 audit report).	UH Board of Regents
1985	*University of Hawai'i Mauna Kea Management Plan.* Revised management plan to address concerns from DLNR and the public. BLNR retained management control over the commercial activities. (1998 audit report)	BLNR
1995	*Revised Management Plan for the UH Management Areas on Mauna Kea.* Adopted by UH and DLNR to improve control over commercial uses in the summit area. All management responsibilities, except those related directly to astronomical facilities or the summit road, are transferred back to DLNR. This plan replaced and superseded the 1985 Management Plan. (1998 audit report)	BLNR
2000	*UH Mauna Kea Science Reserve Master Plan.* Adopted by the UH Board of Regents as the policy framework for the responsible stewardship and use of university managed lands on Mauna Kea. Master Plan created a new management structure, housed within the University of Hawai'i at Hilo, as the local management authority over Mauna Kea. UH also established the astronomy precinct, which confines astronomy development to 525 acres within the MKSR. (2000 audit report).	UH Board of Regents

FLORA AND FAUNA OF MAUNA KEA

High elevation areas on Mauna Kea can be divided into two basic types: the subalpine ecosystem (5,600 ft to 9,500 ft elevation), and the alpine ecosystem (above 9,500 ft). Hale Pōhaku occurs in the upper reaches of the subalpine ecosystem, while the Mauna Kea Science Reserve occurs in the alpine ecosystem.

Subalpine Flora and Fauna (Hale Pōhaku and Access Road)

The subalpine plant community found at Hale Pōhaku consists of clumps of māmane trees interspersed with open areas of bare soil or rocky outcroppings. Native understory plants include grasses (alpine hairgrass and pili uka); shrubs (ʻāheahea, pūkiawe and nohoanu); ferns (kalamoho, ʻiwaʻiwa, and olaliʻi); and vines (littleleaf stenogyne and māʻohiʻohi). Hawaiʻi catchfly, a threatened species under the Endangered Species Act (ESA), has been observed there as well. A variety of invasive weed species such as grasses and common mullein also inhabit the area, and appear to be increasing in abundance.

Māmane woodlands once stretched from sea level on the leeward side of Mauna Kea to the tree line but have been greatly reduced due to habitat alteration at lower elevations; uncontrolled grazing at the higher elevations by feral sheep, mouflon sheep, and goats; and the presence of invasive plant species that inhibit māmane regeneration.

Māmane woodlands are home to a wide variety of native arthropods (insects, spiders), and several native bird species, including the palila, ʻamakihi, ʻapapane, ʻelepaio, ʻakiapolaʻau, and ʻiʻiwi. Māmane trees are the primary food source for birds in the region, providing nectar and seeds on a seasonal basis. The māmane woodlands are also inhabited by many species of non-native birds and mammals (e.g. cats, rats, barn owls, and mongoose) that have a direct impact on native bird populations.

Perhaps the most notable bird species in the māmane woodlands is the palila (*Loxioides bailleui*), an endangered species under the ESA. These unique endemic birds were once common in dry forests on several of the Hawaiian Islands. Habitat alteration, first by humans, and subsequently by grazing mammals, has reduced the palila's range to a small band of māmane woodlands that stretches around Mauna Kea. Palilas eat māmane seeds and moth larva found in the seedpods, and so are dependent on the survival of the māmane woodlands.

Alpine Flora and Fauna (Mauna Kea Science Reserve)

As you travel up the mountain towards the summit, the vegetation decreases in diversity, density and size. Alpine plant communities on Mauna Kea begin just above the treeline, at approximately 9,500 ft, and rise to the summit of the mountain at 13,796 ft. The alpine plant communities can be divided into shrublands, grasslands, and stone desert, though there are no sharp lines of delineation between them and all are characterized as being predominantly barren rock and cinder with scattered sparse vegetation.

Alpine Shrublands and Grasslands

Alpine shrublands are inhabited mainly by low-lying shrubby species (e.g., pūkiawe, ōhelo, and Mauna Kea dubautia); scattered grasses (e.g. Hawaiian bentgrass and pili uka); and native ferns (e.g., Douglas' bladderfern, kalamoho, ʻolaliʻi, and ʻiwaʻiwa). Historically common, but now rare,

species found in this community include ʻāhinahina (Mauna Kea Silversword), lava dubautia, ʻōhelo papa (Hawaiian strawberry), ʻena ʻena, nohoanu and alpine tetramolopium. Several non-native plant species (e.g., hairy cat's ear, sheep sorrel, common mullein, and fireweed) have invaded the alpine shrublands.

Alpine grasslands replace the shrublands around 11,000 ft in elevation, although pūkiawe shrubs can be found in all habitats, all the way to the summit. The alpine grasslands on Mauna Kea, which occur up to 12,800 ft in elevation, are dominated by two native grasses: Hawaiian bentgrass and pili uka.

Relatively few native animal species utilize alpine shrublands and grasslands as habitat. Invertebrates have not been well studied at these locations. Heavy grazing by feral ungulates has decimated the plant communities in the alpine shrublands and grasslands, and invasive plant species now compete with native plants for limited resources such as water and sheltered growing locations.

Mauna Kea Silversword

At one time, the Mauna Kea Silversword, or ʻāhinahina, dominated the alpine landscape on Mauna Kea from 6,000 – 12,300 ft. ʻĀhinahina is a spectacular plant with thick sword-shaped silvery-green leaves growing in a rosette. The population size of the Mauna Kea silversword was drastically reduced through grazing by feral sheep, goats, mouflon sheep and cattle. Recovery efforts for the Mauna Kea silversword are underway through the efforts of federal and state agencies. Recently a new population of Mauna Kea Silverswords was discovered in the MKSR.


Credit: SRGII

Mauna Kea Summit – Alpine Stone Desert

Although it may appear barren to the casual observer, the summit of Mauna Kea supports an interesting variety of species, many of which are found nowhere else in the world. The summit of Mauna Kea (12,800 – 13,795 ft) is considered an alpine stone desert. This plant community consists of mosses, lichens, and algae, and a limited number of vascular plants, predominantly the same species found in the alpine shrublands and grasslands (e.g., Hawaiian bentgrass, pili uka, ʻiwaʻiwa, and Douglas' bladderfern). Most of the species of plants found in the region are endemic (occurring only in Hawaiʻi) or indigenous (native to Hawaiʻi but occurring elsewhere). A few non-native plant species (e.g., hairy cat's ear and common dandelion) have also become established in the summit region at low densities.

Lichens and mosses dominate the alpine stone desert in terms of diversity and abundance. A survey of lichens on the summit of Mauna Kea identified 21 species (plus five possible other species). Around half of the lichen species found on Mauna Kea are endemic (found only in Hawaiʻi), two of which (*Pseudephebe pubescens* and *Umbilicaria pacifica*) are limited to Mauna Kea alone. The remaining species are indigenous to the Hawaiian Islands. *Lecanora muralis* is the most abundant lichen on Mauna Kea; other common species on the summit are *Lecidea skottsbergii* and *Candelariella vitellina*.

Mosses at the summit occur in protected places where water availability is more consistent, such as under overhanging rocks and in shaded crevices or caves where snow melts slowly. A survey of the mosses on the Mauna Kea summit area (above 13,000 ft) identified approximately 12 species (some could not be identified with certainty to the species level), most of which are indigenous to the Hawaiian Islands. Two moss species, *Bryum hawaiicum* and *Pohlia mauiensis*, are endemic. The most common species of moss include a previously undescribed species of *Grimmia* and *Pohlia cruda*.

The animal community at the summit is dominated by arthropods (e.g., insects and spiders). Other than man, very few vertebrate species venture this high. The arthropod community on the summit of Mauna Kea can be divided into two parts: those species that are blown up the mountain from lower elevations by the wind and die there in the cold (referred to as aeolian drift), and those cold-adapted species that are permanent residents, that feed on the aeolian drift or on one-another. The arthropod community on the summit is highly unusual in that it is mostly made up of predators and scavengers, and there are very few species that rely on plants as their sole food source.

Through the various studies conducted at the summit of Mauna Kea, 21 resident species, and 14 species of undetermined origin (unknown if they are resident or aeolian) have been recorded as occurring in the alpine stone desert. Native resident species include the Wēkiu bug, a noctuid moth, a hide beetle, a large wolf spider, three sheet-web spiders, three species of springtails, two species of mites, a bark louse and a centipede. Non-native resident species include a book louse, big-eyed bug, a hunting spider, a sheet-web spider, and an unidentified jumping spider. It is thought that the non-native spiders may be negatively impacting the native arthropods, but their true impact is unknown.

Wēkiu Bug


Credit: Jesse Eiben

The Wēkiu bug (*Nysius wekiuicola*) is the best-studied invertebrate at the summit – there is little information available regarding the habits of most of the other summit species. The Wēkiu bug is a federal candidate species, meaning that it is being considered for listing as threatened or endangered under the ESA, but has not yet been listed. The Wēkiu bug was first recognized as a new species in 1979. It is a true bug in the family Lygaeidae (order Heteroptera), and is approximately the size of a grain of rice. Wēkiu bugs reside in the cinders on the summit of Mauna Kea, where they use their straw-like beaks to suck the hemolymph (blood) from dead and dying insects in the aeolian drift. Wēkiu bugs mainly reside on or near the crater rims of cinder cones that formed nunataks (ice free areas rising above the surrounding glacier) or that lay at the glacier limit during the last glaciation, and are most abundant on the north- and east-facing slopes (and on slopes shaded by local topography), where seasonal snow remains the longest. Wēkiu bugs can often be seen foraging on the edge of snow banks. Crests of glacially overridden cones and inter-cone expanses of glacial till appear to lack suitable Wēkiu bug habitat. Research continues into aspects of the Wēkiu bug's population size and distribution, life history, and genetics.

PHYSICAL RESOURCES OF MAUNA KEA

Rising nearly 33,000 feet from the ocean floor, with a peak elevation of 13,796 feet, Mauna Kea is the highest point in the Pacific Basin and the highest island-mountain in the world. Mauna Kea was listed as a National Natural Landmark in 1972. One of the reasons given for placing the mountain on this register by the National Park Service is that Mauna Kea is the "Most majestic expression of shield volcanism in the Hawaiian Archipelago, if not the world." Other unique geologic features of Mauna Kea include numerous cinder cones (pu'u) that rise above lavas of the upper plateau, and evidence of glaciers that covered nearly 27-square miles of the summit region during the Pleistocene Epoch (Ice Ages) approximately 18,000 years before present.


Credit: SRGII

Geology

'Hawaiian Hotspot' magmas, pushed up through the oceanic crust, began building Mauna Kea approximately 750,000 years ago. Throughout its building stages, a'a and pahoehoe lavas flowed from three main rift zones, forming a volcano resembling a warrior's shield. Towards the end of the post-shield stage eruptions became more explosive, discharging magma referred to as tephra. These eruptions created the numerous cinder cones dotted across the highest elevations of Mauna Kea. The lavas and other volcanic material comprising the mountain yield clues as to how volcanic processes occur and how those processes relate to the formation of our continental crust.

Three cinder cones (*pu'u*) make up the summit of Mauna Kea (Pu'u Hau'oki, Pu'u Wēkiu, Pu'u Haukea), collectively referred to as Pu'u o Kūkahau'ula, a traditional deity associated with fisherman families. There are additional cinder cones (e.g., Pu'u Keonehehe'e, Pu'u Makanaka, Pu'u Poepoe, Pu'u Poli'ahu, Māhoe, and Pu'u Waiau) below the summit that also have traditional cultural significance and associations with Hawaiian deities.

During the Pleistocene Epoch (Ice Ages) the summit region of Mauna Kea, above approximately 12,500 feet, was covered with glaciers. Scientists agree that at least three different glaciers, referred to as members, were presented during the time span of 150,000 to 18,000 years before present. The movements and melting of the glaciers contributed to the unique land shapes and features of the upper mountain, leaving behind glacial moraines and accumulations of glacially transported and deposited rock, ash, and cinder, which can be observed down to elevations as low as 9,875 feet. In addition it is believed that melting of the glaciers was the first source of water for Lake Waiau.

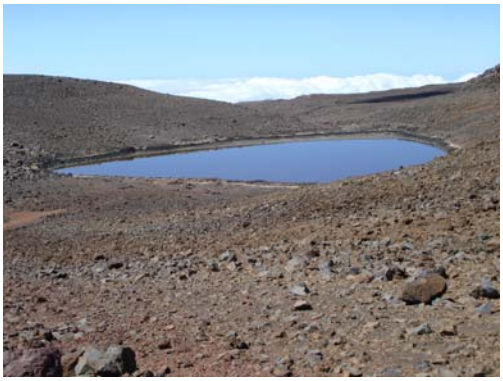
Climate

Above 7,000 feet, the upper slopes and summit region of Mauna Kea are classified as high alpine desert, above the trade wind inversion, where the air is dry and cool. During winter months (November-April) low-pressure systems tend to inhibit formation of the inversion layer, permitting increased precipitation, including snowfall at the summit. Annual precipitation ranges from 7-18 inches in the summit area to 12-20 inches at Hale Pōhaku.

Hydrology

There are seven watersheds with upper boundaries that extend into the MKSR. Water flow in the gulches and streams within the MKSR is ephemeral, and surface flow occurs only during periods of rapid snow melt or during infrequent high magnitude rainfall events. There are several springs along the gulches located below approximately 12,000 feet.

Situated in the adjacent Mauna Kea Natural Area Reserve at an elevation of 13,020 ft, Lake Waiau is one of the world's highest alpine lakes. Approximately 7.5 feet deep at capacity, hydrologic studies of Lake Waiau have determined that snow melt within the crater of Pu'u Waiau and rainfall landing both in the pu'u and on adjacent upslope lands located inside the MKSR are the primary sources of water in the lake. This small body of water holds great traditional significance for many Hawaiian families.



Credit: SRGII

ACCESS

Vehicular Access

The summit of Mauna Kea is accessible from Saddle Road, Route 200, which connects Hilo to Māmalahoa Highway. From Saddle Road at Pu'u Huluhulu, a paved road extends approximately six miles to Hale Pōhaku. From there, the summit access road extends to and loops around the summit for 10 miles. The first 4.6 miles of the road above Hale Pōhaku is unpaved.

There are parking areas near Hale Pōhaku and the Visitor Information Station (VIS). There are three visitor parking areas along the summit access road: just after the paved road begins, near the trailhead to Lake Wai'au, and just past the junction of the access road and the summit loop. Parking is also available at the summit in the vicinity of the telescopes.

Public Access

The public can access the summit of Mauna Kea via the summit access road and hiking trails. There is no restriction to access except when the road is deemed too dangerous because of weather conditions or when there is snow or ice on the road. Hikers are requested to register at the VIS and inform rangers of their travel plans.

Safety

Mauna Kea is a remote locale with no public accommodations. At 13,796 feet the summit is subject to severe weather conditions. This altitude may also cause acute mountain sickness, especially for those who do not take time to acclimate at Hale Pōhaku. The road above Hale Pōhaku is steep, rough, winding, and particularly dangerous in bad weather. Most rental car companies do not permit their cars on Saddle Road (Route 200) or up to the top of Mauna Kea. Only four-wheel-drive vehicles are recommended beyond the visitor center.

UTILITIES

Water and Wastewater

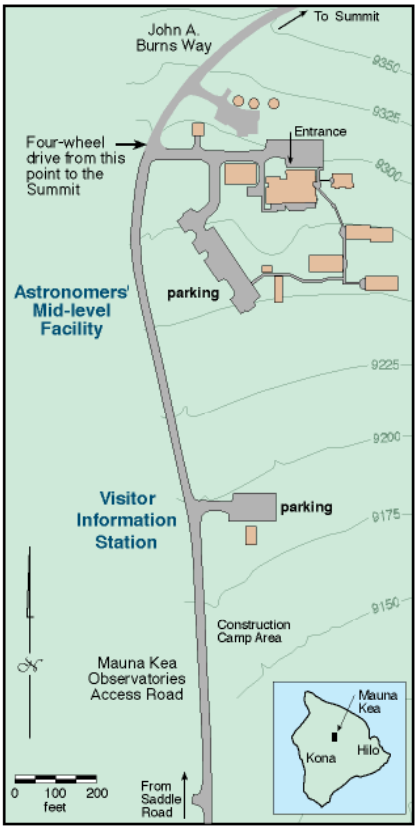
Water is trucked to Hale Pōhaku and the summit from Hilo several times a week.

All sewage disposal and treatment is handled by individual wastewater systems (cesspools and septic tank/leaching field) servicing each facility.

Electricity and Communication

Power and communication lines have been installed underground and support facilities at both Hale Pōhaku and the summit. Electricity for Mauna Kea is presently fed via a 69KV overhead radial feed system to Hale Pōhaku Substation. From this substation there is an underground 12.47KV dual-radial feed system that essentially loops around the Mauna Kea summit.

In the mid-1990s fiber optic lines were installed to provide high-speed communication capability to the Mauna Kea observatories.



Credit: UH Institute for Astronomy

TELESCOPES ON MAUNA KEA

There are currently thirteen telescopes near the summit of Mauna Kea. Nine of them are for optical and infrared astronomy, three are for submillimeter wavelength astronomy and one for radio astronomy. They include the largest optical/infrared telescopes in the world (the Keck telescopes), the largest dedicated infrared telescope (UKIRT) and the largest submillimeter telescope in the world (the JCMT). The westernmost antenna of the Very Long Baseline Array (VLBA) is situated at a lower altitude two miles from the summit *(UH Institute for Astronomy).*

Mauna Kea Telescopes (2008) (http://www.ifa.hawaii.edu/mko/telescope_table.htm)

	Name	Mirror	Owner/Operator	Year Built
Optical/Infrared				
UH 0.6m	UH 0.6-m telescope	0.6m	University of Hawai‘i	1968
UH 2.2m	UH 2.2-m telescope	2.2m	University of Hawai‘i	1970
IRTF	NASA Infrared Telescope Facility	3.0m	National Aeronautics and Space Administration/ UH	1979
CFHT	Canada-France-Hawaii Telescope	3.6m	Canada/ France/ UH	1979
UKIRT	United Kingdom Infrared Telescope	3.8m	United Kingdom	1979
Keck I	W. M. Keck Observatory	10m	Caltech/ University of California/NASA	1992
Keck II	W. M. Keck Observatory	10m	Caltech/ University of California/NASA	1996
Subaru	Subaru Telescope	8.3m	Japan	1999
Gemini	Gemini Northern Telescope	8.1m	USA/ UK/ Canada/ Argentina/ Australia/ Brazil/ Chile	1999
Submillimeter				
CSO	Caltech Submillimeter Observatory	10.4m	Caltech/ National Science Foundation	1987
JCMT	James Clerk Maxwell Telescope	15m	UK/ Canada/ Netherlands	1987
SMA	Submillimeter Array	8x6m	Smithsonian Astrophysical Observatory/ Taiwan	2002
Radio				
VLBA	Very Long Baseline Array	25m	National Radio Astronomy Observatory/ National Science Foundation/ Associated Universities, Inc.	1992

Mauna Kea's Unique Environment for Astronomical Research

The summit of Mauna Kea hosts the world's largest ground-based astronomical observing site, considered to be the finest in the world. Physical characteristics that set Mauna Kea apart from other sites include high altitude, atmospheric stability, minimal cloud cover, low humidity, dark skies (resulting from remoteness from urban development and the County of Hawaii's island-wide lighting ordinance), and the transparency of the atmosphere to infrared radiation. A tropical inversion layer about 2,000-ft thick, between 5,000-7,000 ft, provides the upper atmosphere with a buffer from the lower moist maritime area, keeping it clear, dry and free of atmospheric pollutants. Due to the location of the Hawaiian Islands within the northern hemisphere tropics, astronomers can observe the entire northern sky and nearly 80 percent of the southern sky.

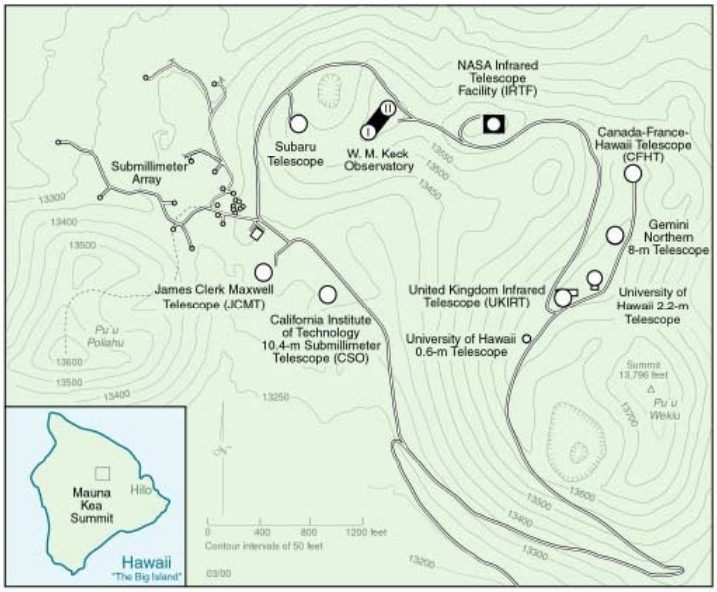
Discoveries Made by Mauna Kea's Telescopes

Over the years, Mauna Kea's telescopes have contributed to a better understanding of our planet and the universe. Following are news articles that highlight some of Mauna Kea's more recent discoveries:

Hawai'i's Mauna Kea Observatory Aids Discovery of Largest Transiting Extrasolar Planet Found Around A Distant Star
The Honolulu Advertiser
November 7, 2007
http://snipr.com/MaunaKea1

Web of dark matter spans space
The Vancouver Sun
February 21, 2008
http://snipr.com/MaunaKea2

UH scientists observe flipping star
The Honolulu Star-Bulletin
February 19, 2008
http://snipr.com/MaunaKea3



Credit: UH Institute for Astronomy

Viewing Time

The University of Hawai'i receives 10 to 15 percent of each telescope's viewing time in place of a monetary rental fee. This telescope time is allotted to UH scientists to conduct research. Telescope organizations pay for operational and infrastructure development costs on Mauna Kea, such as roadway improvements, installation of fiber optics, operation of the Visitor Information Station, and snow removal.

Education

To live and work under the sky of Hawai'i is an extraordinary privilege. The University of Hawai'i's unmatched access to the telescopes and instruments on Mauna Kea represent a unique resource for education and research. The University of Hawai'i at Mānoa offers both a masters and doctorate degree in astronomy and the University of Hawaii at Hilo offers a bachelors degree. The program is designed for students with a strong background in physical science and focuses on training professional astronomers for academic and research positions.

'Imiloa Astronomy Center

Framed by Hawai'i's rich Polynesian tradition of exploration, 'Imiloa Astronomy Center, is Hawai'i's premier facility for interpreting the deepest mysteries of the universe by the Mauna Kea observatories; educating and inspiring students and teachers and communities worldwide; and presenting a global vision of integrated, scientific technological and cultural leadership for 21st century America. 'Imiloa explores the connections between Hawaiian cultural traditions and the science of astronomy. ('*Imiloa Astronomy Center*)

INSTITUTE FOR ASTRONOMY'S LONG-TERM DEVELOPMENT OF OBSERVATORY SITES ON THE SUMMIT OF MAUNA KEA

The Role of Astronomy in Hawai'i

The Institute for Astronomy (IfA) is one of the most respected astronomy institutes in the world. It attracts highly talented faculty and promising students from around the world. It owes this success, in large part, to its access to the world-class observatory complex on Mauna Kea. Rather than expend enormous financial resources to build and maintain these telescope facilities, the University, following the initiative and leadership of IfA, entered into scientific partnerships with national and international partners. Through these scientific partnerships, the observatory organizations provide the funds to build and operate the facilities. The University receives a guaranteed share of observing time at no cost. Most of this is used by IfA astronomers and students (Response to HCR 314, Regular Session of 2006, by Rolf-Peter Kudritzki, Director, Institute for Astronomy, Dec. 1, 2006).

A Modified Plan for Long-Term Astronomical Development on Mauna Kea

It is IfA's goal to sustain Hawai'i's reputation as the premier facility of ground-based astronomy study in the world. This achievement will not only benefit UH as an educational and research institution, but will also have broad educational and economic benefits to the entire state. IfA's modified plan includes the following for the next 20 years:

Submillimeter Array (SMA)

The 2000 Master Plan originally proposed 12 more antennas and 24 new concrete pads for the array; the new modified plan proposes 2 more antennas and two pads. UH is also working on relocating two existing antenna pads located at the base of Pu'u Poli'ahu, a culturally significant site, pursuant to request by Kahu Kū Mauna.

UH Hilo Instructional Telescope

The 2000 Master Plan originally proposed to build a new observatory site on the summit ridge for the UH Hilo instructional telescope. Instead of building on a new site, IfA gave UH Hilo the use of the UH 24 in (0.6 m) telescope site for its instructional telescope.

Pan-STARRS Observatory

Pan-STARRS uses completely new technology to detect killer asteroids that threaten to collide with the Earth. IfA is proposing to redevelop the site of the existing UH 2.2 meter Telescope for Pan-STARRS.

Thirty-Meter Telescope (TMT)

With its 30m-diameter mirror, TMT will be the largest telescope in the world. It will be able to detect the most distant galaxies in the universe, seeing them in a stage when the universe was still very young, just after the Big Bang. Mauna Kea is being considered as a candidate site for the TMT, along with locations in Mexico and Chile. The proposed site for this observatory will be on the northern plateau below the summit ridge. The TMT is a one billion dollar project – the most ambitious project in modern astronomy – and will have an enormous scientific, educational and economic impact. If Hawai'i is chosen as the location, the TMT will secure leadership of Hawai'i in astronomical science for the next few decades.

Obsolete Telescopes

IfA is proposing to demolish some of the old facilities and conduct site restoration.