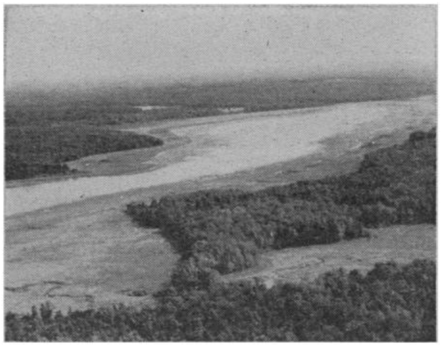

Fig. 1. Lake Ogechie, Minnesota, showing a typical small wild rice lake with emerging rice. The Petaga Point archeological site is at the upper left (southeast) section of the lake. Evidence of rice harvesting is found on all of the points projecting into the lake.

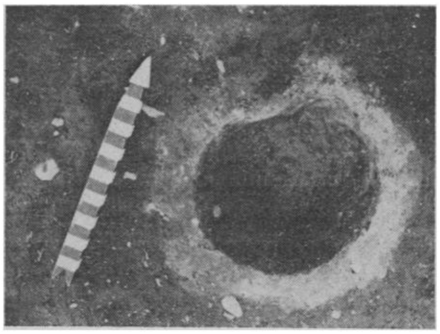

Fig. 2. Thick clay lining of the base of a jig pot excavated at the Lower Rice Lake site. Scale intervals are 2 cm.

Both types of sites are characterized by their location on recently used Chippewa harvest sites, they are on high ground with easy access to the rice lake, and each site on excavation produced quantities of heavy utilitarian pottery and numerous shallow basin-shaped pits excavated into the subsoil.

Direct evidence for wild rice utilization during the prehistoric period comes from preserved rice grains, which are usually charred from the parching activity, and which are recovered from the excavations by means of flotation (*6*). Excavated earth is filtered through a very fine mesh screen in running water allowing the lighter vegetable matter to float to the surface. Wild rice grains obtained in this manner, of course, substantiate a prehistoric origin only when they can be attributed to that era and not to recent Chippewa activity. While the tools and paraphernalia of wild rice harvesting and preparation are not preserved in archeological sites, with the exception of parching vessels, two of the activities associated with the preservation of the grain do leave soil modifications that can be seen by the excavator and provide the necessary context.

At several of the rice-harvesting sites excavated, fire pits have been located, and in three instances, large thick-walled utilitarian pottery vessels have been found crushed in place at the edge of the fire pits. Considerable numbers of charred wild rice grains were found by flotation.

At the same time, shallow basin-shaped depressions excavated into the subsoil were used as threshing pits. Historically, pits like these were dug and lined with a tanned animal hide. The parched rice was placed in the pit, and one individual stood in the pit and by moving his feet over the parched rice, separated the husks from the grain. By means of flotation, quantities of charred rice grains have been recovered from pit fill.

While both the parching fire-pits and threshing pits contribute to the probability that the sites in question were sites of wild rice harvesting, alternative explanations are possible for their presence. Conclusive evidence is present at some of the sites mentioned where the shallow threshing pits have their basal section lined with a thick, unfired clay, apparently placed at the base of the pit to provide a stable surface against which to thresh the rice grains (Fig. 2). A long-time resident of the village immediately identified those at the Nett Lake ricing site as "jig pots" or "dance pots." Other Chippewa informants confirmed this identification. The phrase "jig pot" refers to the movement of the feet of the thresher who appeared to be dancing as he moved his feet over the rice grains.

That the jig pots are prehistoric in origin in many cases is again demonstrated by flotation where the clay lining or plug itself was carefully screened. In addition to wild rice grains, numerous small sherds of late prehistoric pottery were found in the screen after the clay had washed through the mesh. Examples of such clay lined pits have been located at Nett Lake, Lower Rice Lake, and at Petaga Point (*7*).

ELDEN JOHNSON
Department of Anthropology,
University of Minnesota,
Minneapolis 55455

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Eolian Origin of Quartz in Soils of Hawaiian Islands and in Pacific Pelagic Sediments

Abstract. *The particle-size distribution and oxygen-isotopic composition of quartz isolated from Hawaiian soils, east-central Pacific sediments, and tropospheric dusts are remarkably uniform. A common origin and tropospheric transport from continental land masses is suggested.*

Soils of the Hawaiian Islands frequently contain quartz in spite of the fact that this mineral has not been detected in unaltered Hawaiian rocks (*1*). Local hydrothermal activity in rocks of the Kailua Volcanic Series in southeastern Oahu has given rise to hydrothermal quartz (*2*), but this is of very limited areal significance. Several workers concluded that the quartz in Hawaiian soils is pedogenic (*1, 3*). We studied the particle-size distribution and oxygen-isotopic composition of quartz isolated from soils of the Hawaiian Islands and found that the isotopic results were remarkably similar to those obtained for pelagic sediments from the east-central Pacific (*4*) and for tropospheric dusts.

Monomineralic quartz was isolated from all samples by a procedure (*5*) involving fusion with $Na_2S_2O_7$ and treatment with H_2SiF_6 and yields quartz with oxygen isotopes unchanged. Results from x-ray study showed that this procedure effectively removed mica, feldspar, and small amounts of other minerals from a sample of tropospheric dust (*6*).

Particle-size distribution was determined by sedimentation and decantation (*7*). Oxygen was liberated from the quartz by reaction with bromine pentafluoride (*8*), and isotopic analyses were carried out with a 6-inch (15-cm) radius, 60°-sector, double-collecting mass spectrometer. Manometric determination of oxygen yields with an accuracy of ± 1 percent provides a test of purity of the quartz isolate.

The results for the quartz content of several soils (*9*) from the Hawaiian Islands are shown in Fig. 1. For surface soils on the island of Oahu, the quartz content increases functionally with elevation and precipitation (*10*), but when samples from the other islands are included this relation is complicated by geomorphic site factors such as age and stability of the surface, incidence of ashfalls, and others. The quartz contents of the surface horizons of Paaloa and Olokui soils, developed on old landscape positions on the island of Oahu, are 13 and 45 percent, respectively. These high values are striking, indeed, in view of the fact that quartz was not detected in four typical samples of Hawaiian basic rocks and pyroclastic materials (a volcanic cinder from Kilauea, a weathered basalt, an unweathered andesite, and a weathered pumice). Our finding of quartz in the plastic underclay deposits of Kanaele and Alakai swamps on the island of Kauai confirms previous findings (*11*). Quartz was not, however, identified in unweathered rocks on Kauai (*12*), and was virtually absent from the saprolite underlying the plastic clay deposits (*11*).

The particle-size distribution of the quartz isolated from several soils of the Hawaiian Islands is remarkably uniform (Table 1), considering the diverse nature of these samples which include a buried plastic clay lens from the island of Hawaii, underclay deposits from swamps from Kauai, and surficial A and B soil horizons from Oahu and Molokai. Approximately 70 percent of the particles fall within the 10 to 2 μ fraction characteristic of aerosols. Other workers commented on the fineness of the quartz in Hawaiian soils (*1, 11, 12*). If the quartz had formed in these soils by a pedogenic process it is unlikely that the particle-size distribution would be so uniform. In addition, the quartz particles in Hawaiian soils lack crystal morphology and are found as chips and shards identical to quartz in deep-sea pelagic sediments. Hydrothermal quartz occurring in southeastern Oahu is typically larger than 10 μ and shows normal quartz-crystal morphology. It frequently occurs in veins and as crystal coatings lining vesicles in the altered volcanic rocks.

Table 1. Particle-size distribution of quartz isolated from selected soils of the Hawaiian Islands.

Sample			Quartz (%)	Particle-size distribution of quartz (%)			
Description	Number	Location		$>50 \mu$	50 to 10 μ	10 to 2 μ	$<2 \mu$*
Paaloa A1	G-13	Oahu	12.6	3	5	74	18
Paaloa A2 No. 1	66-20	Oahu	13.4	4	5	65	26
Paaloa A2 No. 2	66-21	Oahu	22.3	8	6	72	14
Paaloa B	66-22	Oahu	12.1	4	3	72	21
Olokui A1	66-23	Oahu	44.6	2	2	70	26
Olokui A2	66-24	Oahu	34.4	0	1	64	35
Plastic clay lens	66-50	Hawaii	10.3	1	5	66	28
Titaniferous laterite	66-52	Molokai	10.7	2	2	71	25
Halloysitic underclay	Mc4A	Kauai	12.7	5	6	68	21
Halloysitic underclay	Mc8B	Kauai	17.1	3	6	72	19
Halloysitic underclay	A110C	Kauai	7.8	6	11	73	10

* Calculated by difference and includes mechanical loss, weighing errors, and others.

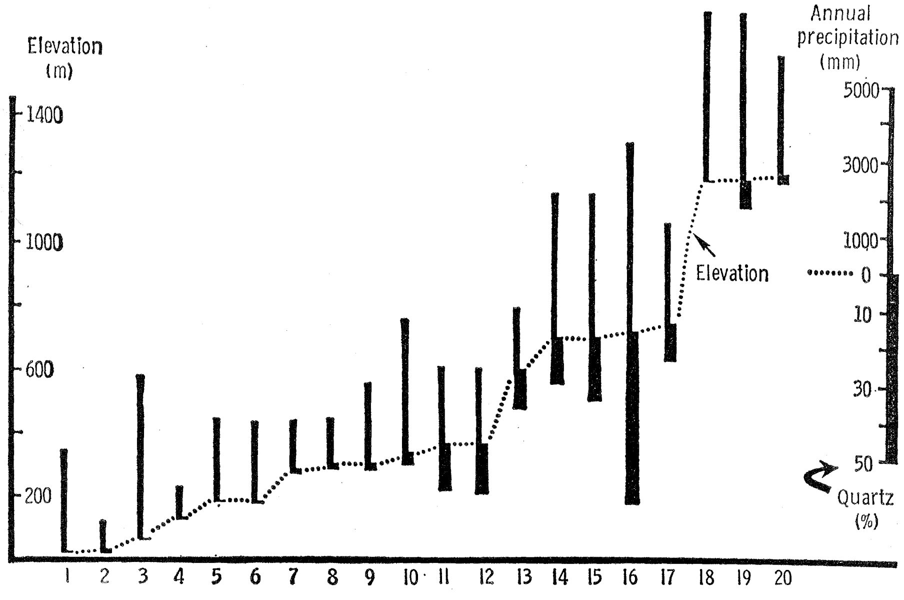

Fig. 1. Quartz content of surface horizons of soils of the Hawaiian Islands in relation to elevation and precipitation. Sample numbers: 1, Waimanalo, Oahu; 2, Molokai, Oahu; 3, Honomu, Hawaii; 4, Molokai, Oahu; 5, Knudsen, Kauai; 6, Knudsen, Kauai; 7, Wahiawa, Oahu; 8, Wahiawa, Oahu; 9, Kilohana, Kauai; 10, Pali, Oahu; 11, Paaloa, Oahu; 12, Paaloa, Oahu; 13, Meyer Lake, Molokai; 14, Kanaele Swamp, Kauai; 15, Kanaele Swamp, Kauai; 16, Olokui, Oahu; 17, Honokaa, Hawaii; 18, Alakai Swamp, Kauai; 19, Alakai Swamp, Kauai; 20, Kalalau Lookout, Kauai.

The mean oxygen isotopic composition of quartz isolated from 15 soils is 17.51 ± 0.36, and the standard deviation is unusually small (Table 2). Furthermore the values for $\delta^{18}O$ are vastly different from the value of 32 found for Cretaceous cherts (*13*) and from the value of 5 to 6 for hydrothermal quartz from Oahu (Table 3). The oxygen isotopic composition of quartz depends strongly on the temperature of formation of this mineral (*14*). Had the Hawaiian quartz formed pedogenically, then its oxygen isotopic composition would reflect a low temperature of formation; that is, high $\delta^{18}O$ values comparable to those for chert.

Quartz is a common constituent of pelagic sediments of the Pacific Ocean, and an eolian or tropospheric origin for this mineral has been suggested on the basis of the marked narrow size-frequency distribution of approximately 10 to 2 μ and the latitudinal dependence of the quartz concentration (*15*). Studies on the oxygen isotopic composition of quartz isolated from east-central Pacific sediments (*4*) show that the oxygen isotopic composition for a given size fraction (for example, 10 to 2 μ) is very uniform in each of the cores analyzed. The mean $\delta^{18}O$ value of quartz from over 20 samples was 17.80 ± 1.21, a value almost identical to that obtained for the quartz isolated from soils of the Hawaiian Islands. When the $\delta^{18}O$ values of the separated 10 to 2 μ fraction of quartz from the Pacific sediments are compared to those obtained for the Hawaiian soils, the results are indistinguishable. The significance of this coincidence is enhanced by the fact

Table 2. Oxygen-isotopic composition of quartz isolated from selected soils of the Hawaiian Islands.

Soil description	Sample No.	Quartz (%)	$\delta^{18}O$*
	Oahu		
Wahiawa A1	66-15	1.6	17.14
Paaloa A1	G-14	12.6	17.48
Paaloa A2 No. 1	66-20	13.4	17.75
Paaloa A2 No. 2	66-21	22.3	17.83
Paaloa B	66-22	12.1	18.03
Olokui A1	66-23	44.6	17.99
Olokui A2	66-24	34.4	17.63
Pali A	C-25	3.4	17.21
	Kauai		
Plastic underclay	Mc8B	17.1	17.41
Plastic underclay	A110C	7.8	17.37
Plastic underclay	Mc4A	12.7	17.08
Kauai No. 38	K-38	2.4	16.77
	Molokai		
Titaniferous laterite	66-52	10.7	17.53
	Hawaii		
Plastic clay lens	66-50	10.3	17.61
	Maui		
Maui No. 55	M-55	1.8	17.83
		Mean	17.51 ± 0.36

$$* \delta^{18}O = \left[\frac{^{18}O/^{16}O\ (\text{sample})}{^{18}O/^{16}O\ (\text{standard})} - 1\right] 1000$$

relative to standard mean ocean water.

that this is an unusual isotopic composition for quartz, being at the high end of observed values for igneous and metamorphic rocks, and at the low end of the distribution of values for low-temperature chemical sediments.

The quartz content of tropospheric dusts collected in Japan (*6*) and in Barbados are 32 and 10 percent, respectively. Furthermore the particle-size distribution of these materials (dominantly 10 to 2 μ) and the oxygen isotopic composition of the quartz ($\delta^{18}O$ = approximately 16) are almost identical to those of the quartz isolated from soils of the Hawaiian Islands and the pelagic sediments of the east-central Pacific.

These findings indicate an eolian origin for the quartz in virtually all Hawaiian soils, and negate the possibility of a pedogenic origin (*1, 3*). Transport of eolian material by the principal wind systems of the troposphere from semiarid and arid land areas with subsequent deposition in rain appears highly probable. An eolian origin is the only evident mechanism which can provide for the distribution of quartz both to the subaerial surfaces of the Hawaiian Islands and across the entire Pacific Ocean.

Table 3. Oxygen isotopic composition as related to the origin of quartz.

Origin	Analyses (No.)	$\delta^{18}O$ (mean)
Hawaiian soils	15	18
Pacific pelagic sediments	22	18
Tropospheric dust	2	16
Hydrothermal (Oahu)	3	6
Chert, Cretaceous (*13*)	12	32

In addition to quartz, the tropospheric dusts analyzed usually contained appreciable amounts of mica and feldspars and often smaller quantities of vermiculite, chlorite, amphibole, calcite, and dolomite. The covariant relation between the mica and quartz contents of Hawaiian soils, both increasing with an increase in rainfall and both concentrated in the surface of the profile (*1*), may suggest that at least a portion of the mica in soils of the Hawaiian Islands also has a tropospheric origin.

R. W. REX
Department of Geology,
University of California, Riverside
J. K. SYERS, M. L. JACKSON
Department of Soil Science,
University of Wisconsin, Madison
R. N. CLAYTON
Enrico Fermi Institute, University
of Chicago, Chicago, Illinois

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Cloud Condensation Nuclei from a Simulated Forest Fire

Abstract. *Measurements made downwind of a simulated forest fire showed that the concentration of cloud condensation nuclei active at a supersaturation of 1 percent was increased by a factor of about 2.5. Smaller increases were observed at lower supersaturations.*

Particles in the atmosphere which act as centers for the condensation of water vapor at supersaturations of less than a few percent are important as potential condensation nuclei in the formation of water droplets in clouds and fogs. The concentration of these cloud condensation nuclei (CCN) in the air determines the concentration of cloud droplets, and this in turn controls the size of the droplets and the efficiency with which precipitable particles can be produced in a cloud (*1*).

The principal sources of CCN are not well known. In general, however, the continents are a source and the oceans are a sink. Twomey (*2*) and Squires (*3*) have shown that on a global scale the anthropogenic production of CCN is only a few percent of the production by natural sources. In the United States it is about 15 percent, whereas in highly industrial cities the anthropogenic production might approach that due to natural causes.

Smoke from sugar cane fires is a prolific source of CCN, and these fires can greatly increase the concentration of droplets in clouds which form downwind (*4*). Moreover, Warner (*5*) indicates a progressive decrease in rainfall at stations in the Bundaberg district of eastern Australia lying downwind from areas where sugar cane is regularly fired prior to cutting. We describe here measurements of the concentration of CCN downwind from a simulated forest fire.

At the University of Washington's research station at Pack Forest near Eatonville, Washington, a roughly rectangular area (about 12 hectares) was piled with small trees (mostly browned evergreens), brushwood, and logging wastes to simulate a wooded area. When the fire was ignited they initially burnt fiercely but the intensity decreased significantly within an hour. The fire would probably be classified as "cold," since although small branches were burnt the larger tree trunks were only blackened.

The concentrations of CCN in the air were measured with the automatic counter described by Radke and Hobbs