

Pre-Hispanic Workshop of Serpentine Artifacts, Venezuelan Andes, and Possible Raw Material Source

Abstract. *Excavations of a workshop and cemetery in the high Venezuelan Andes yielded winged artifacts made of serpentinite at various stages of finish. Serpentinites are unknown in the Venezuelan Andes, and the raw material was obtained from natural sources located in northern South America or possibly the Antilles, or by trade.*

Recent excavations in the Mucuchíes area (1), Mérida State, in the Venezuelan Andes (Fig. 1A), have uncovered a workshop and cemetery of artisans containing winged artifacts made of serpentinite and steatite. These rock types are unknown in the Venezuelan Andes, and the raw material was obtained either by trade or by mining expeditions from localities along the northern edge of South America, probably the Caribbean Mountains or the Paraguaná and Guajira peninsulas. A source in the Antillean islands (Fig. 1A) is also possible, especially Cuba. This is the first time that a joint cemetery and artisans' workshop in which exotic raw materials of this nature were found has been reported in the Intermediate Area and the Caribbean, and the discovery constitutes evidence of possible trade contacts between these two regions.

Batwing pendants with clear cultural and temporal identification have been found at two archeological sites in the Venezuelan Andes (Fig. 1A): Miquimú (2, 3), in the *tierra templada* Carache area (9°35.6'N, 70°15.2'W), Trujillo State, and El Mocao Alto (1), in the *tierra fría* Mucuchíes area (9°19'N, 71°8'W). The Miquimú site, excavated in 1963–1964, is located on the bank of the Miquimú Creek, a tributary of the Carache River. This was the first habitation site at which six complete batwing pendants and 258 fragments (most consisting of serpentinite, and a few of chert) have been found associated with crude pottery of the Miquimú Plain and Miquimú Plastic types. A radiocarbon date of A.D. 650 enabled us to place the Miquimú phase into period III of the regional chronology (4, 5). The El Mocao Alto site, excavated in 1967–1968, yielded winged pendants at various stages of completion (Fig. 1B), as well as fragments of raw material associated in situ with pottery of the Chipepe Plain, El Mocao Alto Plastic, Mirinday Painted, and El Chao Painted-Plastic types, as well as other cultural material of the Mucuchíes phase (6). Radio-

carbon dates, averaging A.D. 1100 (7), and stylistic comparisons have enabled us to place the Mucuchíes phase into the Protohistoric and Early Historic periods IV and V (A.D. 1000 to after A.D. 1500) of the regional chronology (4). The pendants are made of serpentinite and steatite (8). Petrographic and x-ray diffraction analyses of 17 representative samples showed that the serpentinites are composed mostly of antigorite, with minor amounts of talc, magnetite, and carbonates. The steatites consist mostly of talc, with lesser amounts of antigorite, chlorite, magnetite, and carbonates.

It is clear that El Mocao Alto was the workshop and cemetery of the artisans who made the pendants, because 18 human skeletons were found in situ. The dead were surrounded by serpentinite raw material, unfinished specimens, and grinding and polishing stones, and covered with stone slabs. Well-made complete polished specimens (Fig. 1B), called "batwing" pendants (3), were found lying on the chests of the dead as votive paraphernalia. A total of 4881 pendants or pendant fragments were found at this site, ranging in size from very small pieces (5 by 2 by 0.1 cm) to large, heavy plaques (75 by 15 by 2.5 cm).

Typical batwing pendants have a central triangle which rests between two wings, with two perforations drilled through the base of the triangle for suspension. The extremities of the specimens are often beveled and smoothed. Many unfinished specimens, or debris material, show traces of grooves, from which smaller pieces have been separated and made into smaller artifacts (Fig. 1B). Several large polishing and grinding stones of banded gneiss (a common rock in the Mucuchíes area), and used to make the artifacts, were found associated with the serpentinite pendants. There are many speculations concerning the use of winged ornaments: they may have been used as musical instruments, chest or war ornaments, totems or

sacred symbols of the Andean aborigines, or as currency. The Mucuchíes specimens were used as funerary ornaments (they were found associated with the dead).

In the Intermediate Area and the Caribbean, lithic winged and other pendants made of different rock types (jade, nephrite, chert, and serpentinite) and of shell have a wide distribution (9). In Venezuela, most specimens have been found in caves in the northeastern Andes, and the western and central parts of the Caribbean Mountains (Lake Valencia). Thus far, owing to their uncertain temporal and spatial position, the true archeological significance of these pendants was unknown. Along the north coast of Colombia, such specimens occur in great quantity in the Sierra Nevada de Santa Marta region, and as intrusive trade objects in some sites on the lower Magdalena River. They have been found in the Chiriquí Province in Panama, and in the Antilles they occur as far away as Puerto Rico, where they are made of stone and shell. The finest winged ornaments come from Costa Rica (Nicoya and Línea Vieja areas); these specimens were carved from jadeite and agate in the form of bats, with bodies in relief and elaborately carved wings. For neither area is the source of the jade known.

Serpentinite and related ultramafic rocks are widely distributed in the Caribbean area (Fig. 1A). However, they have not been found in the Venezuelan Andes, and probably never will be, because this mountain range is of cordilleran type, and serpentinites are typical of alpine mountain ranges (10). In our search for the source of the raw material we sampled the important outcrops of serpentinite and related ultramafic rocks in the Caribbean Mountains and the Paraguaná Peninsula (Fig. 1A). Most of the localities yielded typical serpentinites, which consist of antigorite, chrysotile, and bastite in varying amounts, with minor quantities of talc, magnetite, chlorite, spinel,

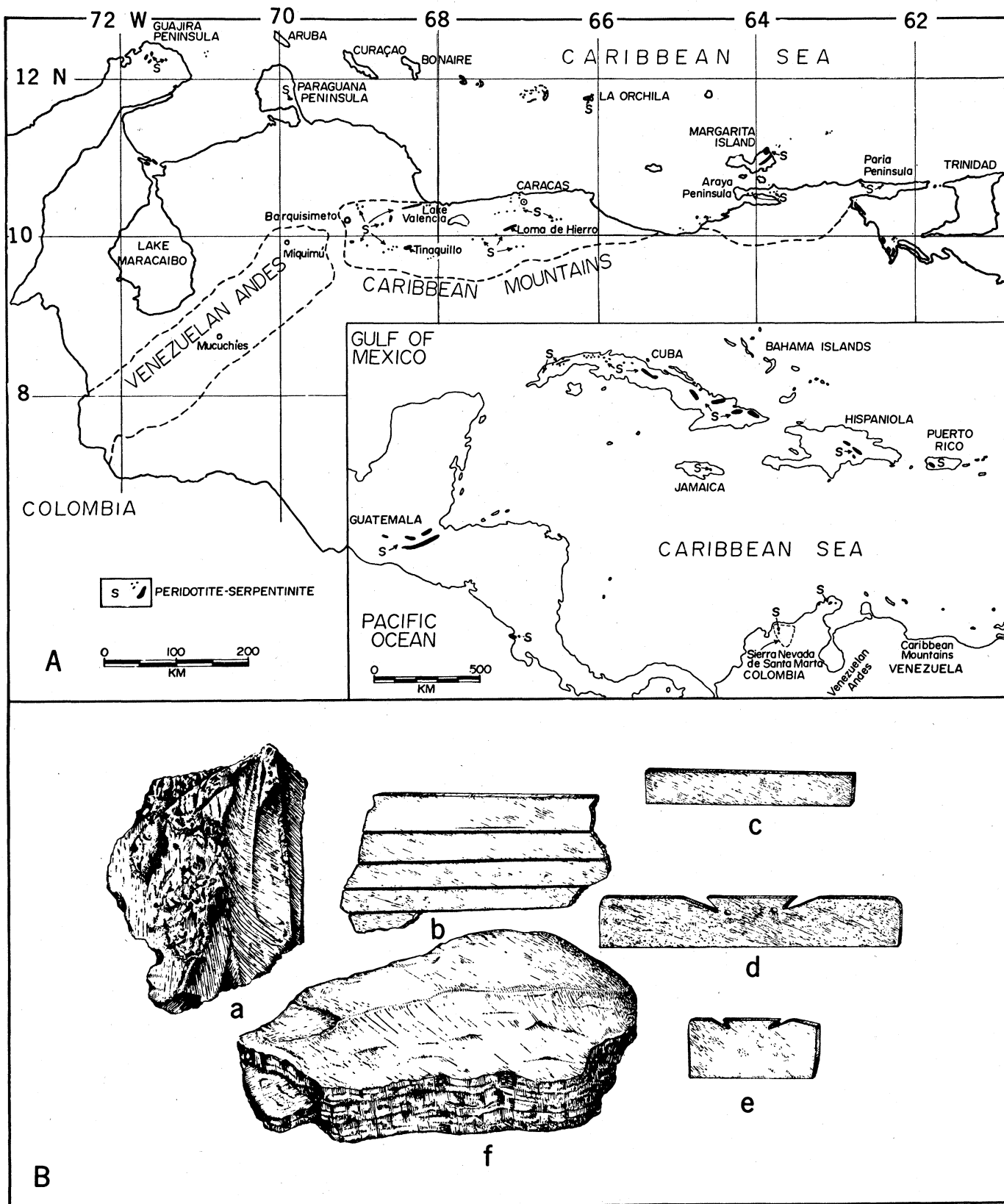
Fig. 1. (A) Index map of northern Venezuela and the Caribbean area, showing the localities of serpentinite bodies (2). (B) Serpentine artifacts from the El Mocao Alto site, Mucuchíes area, Venezuelan Andes ranging from raw material (a) to well-finished artifacts (d and e); (f) represents a gneiss grinding and polishing stone. Size ranges of artifacts are mentioned in the text.

and carbonates. One locality from the Guajira Peninsula yielded a talc-rich serpentinite, close in composition to the steatite mentioned above. Steatites are uncommon rocks in the serpentinite bodies of the Caribbean Mountains, having been described so far only in

one locality, just southeast of Barquisimeto (11).

Our preliminary analyses indicate that the most probable sources of raw serpentinite material used for making winged pendants are the western Caribbean Mountains or the Guajira Penin-

sula, or both. The Sierra Nevada de Santa Marta, Colombia (Fig. 1A), should not be dismissed either as a possible source, since small quantities of raw material as well as winged pendants are present there also, unfortunately of unspecified rock type. A



more distant origin in the Caribbean is also possible in view of the fact that serpentinite deposits exist in Cuba, Hispaniola, and Puerto Rico. Furthermore, stoneworking and seafaring skills were well developed in the Antilles long before contact with Europe occurred (12). This report suggests alternative sources of raw materials for the pendants. However, our data are still insufficient to throw light on the interesting problems related to the transport of winged pendants within northern South America, Central America, and the Caribbean area.

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14. We thank J. P. Lockwood for providing samples of serpentinites from Guajira Peninsula, Compañía Shell de Venezuela for preparing thin sections, and C. Quintero for drawing Fig. 1B. The serpentinite localities of the Guajira Peninsula (Fig. 1A) were derived from theses (Princeton University, Princeton, N.J.) by J. P. Lockwood (1965), W. D. MacDonald (1964), and W. Alvarez (1967).

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Lead-212 in the Urban Boundary Layer of New York City

Abstract. The radioactive emanation product lead-212 is useful in estimating rates of air exchange within the urban boundary layer. The concentration of lead-212 is negligible in air of oceanic origin as well as in air above continental areas under snow cover. On several days when conditions were such that one of these types of air mass approached New York City, measurements were made which show that the source strength of lead-212 within the city is relatively constant. On two such days vertical profiles of the concentration of lead-212 were measured from the Empire State Building, which served as a sampling tower. From the data of these profiles and a two-layer model of the urban boundary layer, we estimate the vertical eddy diffusivity to be of the order of tens of square meters per second and the residence time of air within the street layer to be of the order of 5 minutes. These results are consistent with the observed distribution of stable lead and with an independent estimate of the eddy viscosity from a wind profile. Under moderate wind conditions and with a mixing depth of hundreds of meters, virtually all the horizontal transport of lead-212 and other tracers with street-level sources takes place in the advective layer.

The level of air pollution in a city depends greatly on the rates of mixing and renewal of the air within the urban boundary layer. Patterns of air flow at street level are so complicated that it is impossible to estimate the renewal rate of air by direct measurements of the wind field and temperature profiles. The exchange rates of air must therefore be measured by tracer techniques.

The emanation products of the noble gas radon and thoron and their daughters (1) provide a set of natural radioactive tracers that are applicable to this problem because they are easy to measure experimentally (2, 3), are produced over all continental areas, and the theory of their transport has been developed (4, 5). In this report the utility of ^{212}Pb , a daughter product in the thoron chain, is emphasized because its half-life (10.6 hours) is sufficiently short that it should respond to local and diurnal meteorological conditions and sufficiently long that it should reflect average exchange conditions on an urban scale. Also, it is present on particles small enough to respond to air mass movements. New York City is appropriate for testing the utility of this radioisotope because it is adjacent to the Atlantic Ocean. In general, emanation products from oceanic areas are negligible compared to those from continental areas, and this is particularly true of the thoron chain. Thus when an air mass of oceanic origin (a southeast wind in the case of New York) approaches the city, the ^{212}Pb source characteristics of the city itself can be directly measured.

Measurements were made of the concentrations of ^{212}Pb , particulates, ^{222}Rn , and in some cases total particulate lead (6). Appropriate meteorological data were obtained from the U. S. Weather

Bureau. Our preliminary results suggested that a two-layer mathematical model could be used for treating air transport and exchange within the urban boundary layer, and the results are discussed in this context. We realize that the real urban situation is more complex than that portrayed by such a simple model, but we believe that the lack of vertical resolution in our sampling precludes the use of a more complicated model. Figure 1 shows the four sampling sites in New York City's Borough of Manhattan, their geographic

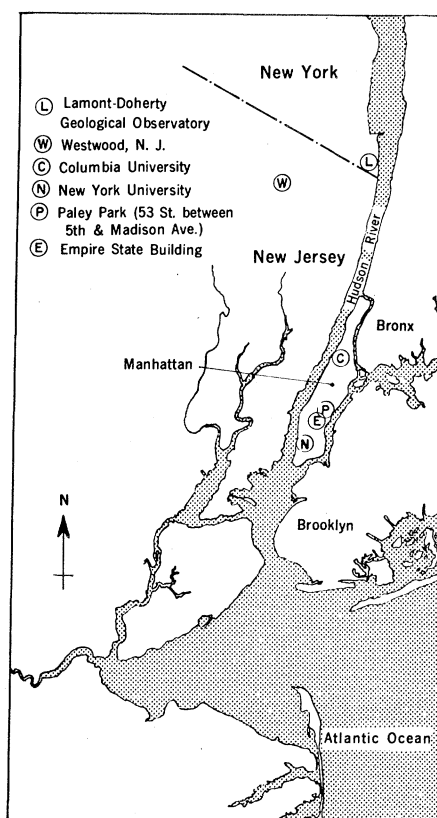


Fig. 1. Map showing sampling locations in the New York City metropolitan area.