Technological and Functional Analyses of Lithic Flake Tools from Rabel Cave, Philippines

by Wilfredo Ronquillo

In 1976-77, archaeological explorations of cave sites were undertaken at the limestone formation area of Penablanca, Cagayan Province, Northern Luzon, Philippines to search for Palaeolithic sites. The explorations resulted in the discovery of 78 caves and rockshelters, 43 of which contained archaeological materials on their floor surfaces. The materials recovered range from Palaeolithic flake and cobble tools to stoneware sherds of Chinese provenance.

Subsequent archaeological excavations were carried out in a number of caves to determine the extent of the Palaeolithic industry (ies) in the area, both spatially and temporally, and to try to explicate the structure of the Palaeolithic industry(ies) there by employing technological and functional analyses on the lithic materials recovered.

The purpose of this paper is to determine the existence or absence, if the data warrant it, of technological and functional variability in the lithic flake tools recovered from the archaeological excavations of Rabel Cave, one of the caves excavated in the Penablanca limestone area. Specifically, it aims to test the hypothesis that the utilized flake tools recovered from Rabel Cave are maintenance tools.

Reprinted from the Anthropological Paper No. 13 of the National Museum, Manila, Philippines, December 1981. *W. Ronquillo is the Chief Archaeologist of the Anthropology Division of the National Museum and Chairman of the SPAFA Philippine National Steering Committee.*

Description Of The Area

Cagayan Valley, Northern Luzon, Philippines presently forms a large basin which is surrounded, except in the north, by high mountains: the Cordillera Central in the west, the Sierra Madre in the east and the Caraballo in the south. The valley, which is approximately 250 kilometers long by 50 kilometers wide, falls within the provinces of Nueva Vizcaya, Isabela, Kalinga-Apayao and Cagayan.

Cagayan Province, where the limestone cave sites are located, comprises an area of 900,267 hectares (Dagdag 1967). Tuguegarao, its capital, is roughly 500 kilometers north of Manila.

The climate of Cagayan Valley does not have a very pronounced wet season. It has a short dry season which generally lasts from one to three months. The annual precipitation in the northern Cagayan Valley is only 35 inches but the range of the annual rainfall received by most of the valley stations is from 60 to 80 inches (Wernstedt and Spencer 1967:316). The months from December to May are normally quite dry since the precipitation is so distributed while the remaining months of the year are humid and wet.

The Cagayan River is the master stream of the valley and all of the drainage of this region is toward the north. Numerous tributaries make up Cagayan River as it treks northward resulting in a one-sided character of the valley. Since the main stream is entered by tributaries mostly from the Cordillera to the west, the majority "of the alluvial plain lies to the west of the main river channel" (ibid.).

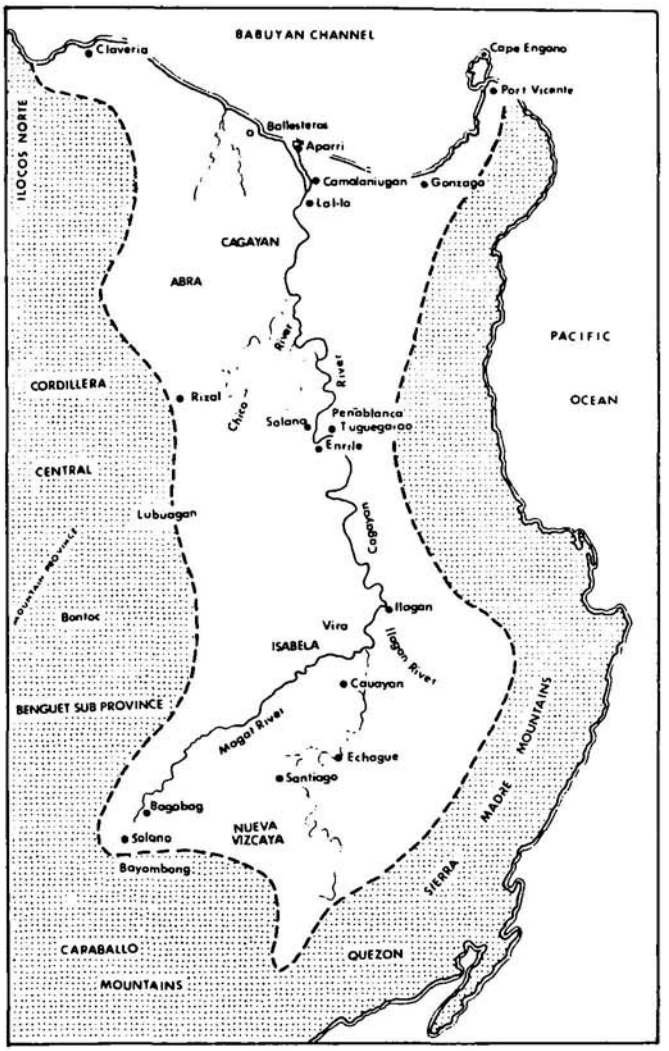
The Geology of Cagayan Valley

The Cagayan basin was formed as a deeply subsiding marine trough during the Oligocene (25 to 35 million years ago) and was subsequently filled by more than 10,000 meters of debris flows deposited on a basement of igneous volcanic and 400 to 2,000 meters of Pliocene transitional marine and fluvial sands of the Ilagan Formation (Corby 1951; Durkey and Pederson 1961).

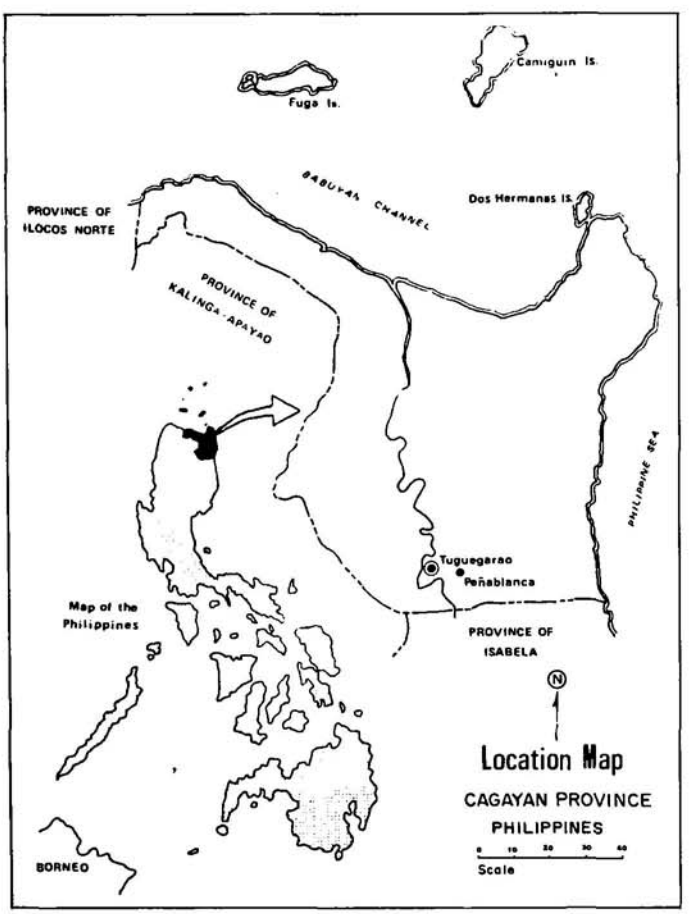
Overlying the Pliocene Ilagan Formation is a 300-meter thick sequence of Pleistocene tuffaceous fluvial sediments assigned to the Awidon Mesa Formation (Durkee and Pederson 1961).

It has been advanced that during the development of the Cagayan basin the Sierra Madre Mountain has been relatively stable and, therefore, a more passive element; the Cordillera in the west, on the other hand, has been considered the dominant tectonic feature of Northern Luzon. During the Palaeocene and persisting into the Pliocene, marine conditions prevailed in the basin. As the Cordillera Central was uplifted during the Upper Cretaceous and the Lower Tertiary, the Cagayan basin was initiated (ibid.).

The basin progressed from deep marine to shallow water during the Upper Miocene. That the final period of uplift in the Cordillera Central lasted from the late Pliocene to the early Plesistocene and that



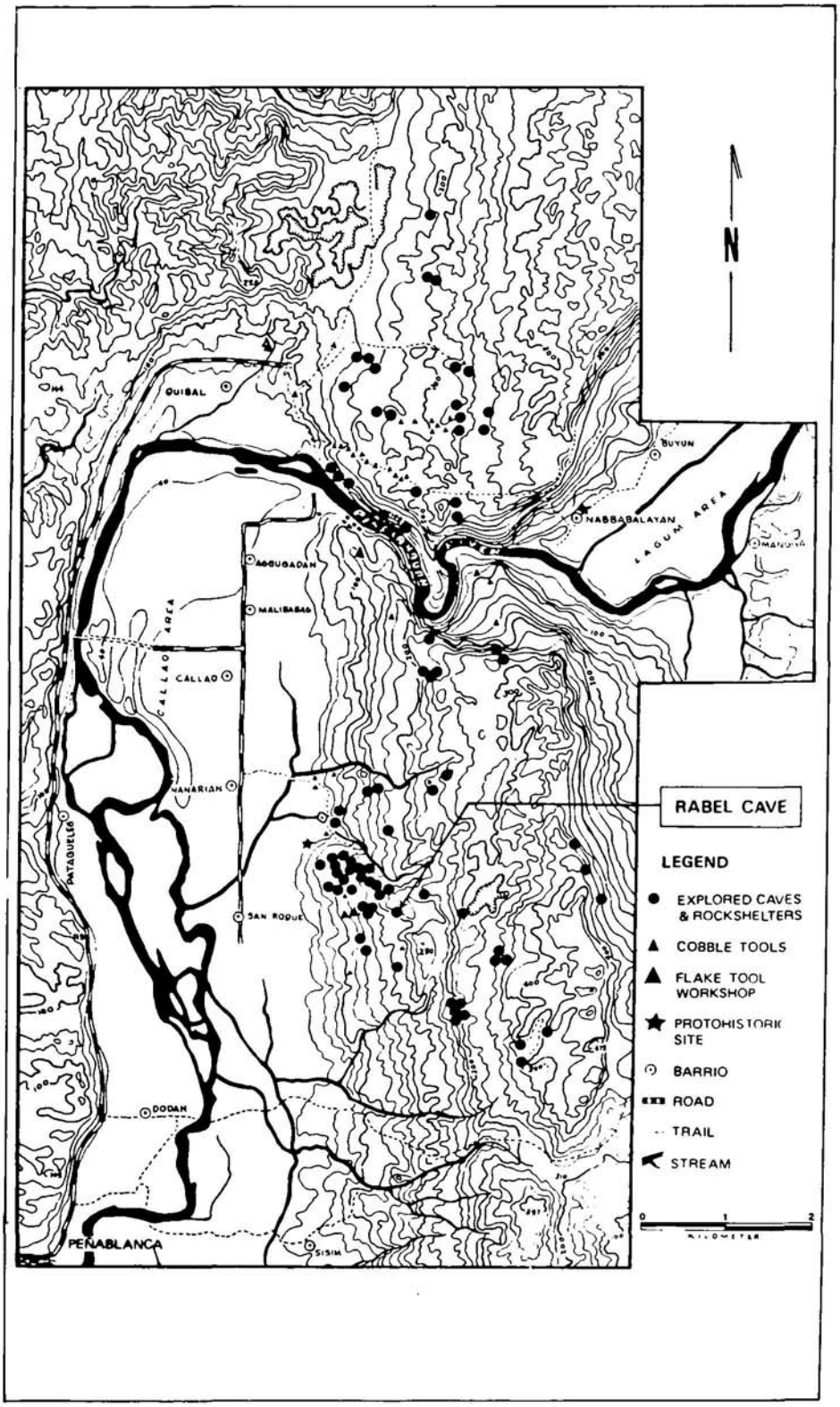
The Cagayan Valley Region, Northern Luzon, Philippines.



these events resulted sometimes in assymetrical anticlines and intervening synclines were considered by Durkee and Pederson (1961).

Penablanca Municipality

The municipality of Penablanca, the largest municipality in Cagayan Province, is 9 kilometers east of Tuguegarao and has a total land area of 118,060 hectares (PDS 1975). The name of the municipality means "White Rock" or "White Stone" and was derived from the white limestone outcrops that are conspicuously seen from a distance. Penablanca is bounded on the east by the Philippine Sea; on the north



Map of Penablanca Limestone Formation and the distribution of Archaeological sites explored by the National Museum from November 22, 1976 to February 20, 1977.

by the municipality of Baggao; on the south by the municipality of San Pablo, Isabela Province; and on the west by the municipalities of Tuguegarao, Iguig and Amulung. At the time of the excavation, it has a population of 20,644. The main source of livelihood of the residents is farming with corn, rice, tobacco, beans, peanuts and mongoes as the major agricultural products (Yambot 1975).

The limestone formation of Penablanca has an estimated area of 77 square kilometers and an average elevation of 309 meters above the alluvial plain which, in turn, is roughly 40 meters above mean sea level. It is at this limestone formation area where the archaeological explorations and excavations were undertaken.

Rabel Cave

Rabel Cave, one of the larger caves at the limestone formation of Penablanca Municipality, Cagayan Province, is located at the western slope of the limestone outcrop and presently falls within Barrio San Roque. The cave's elevation is 213 meters above mean sea level. The entire limestone area is covered predominantly by abundant vegetation, hence, the caves and rockshelters cannot be seen from the floodplain where a number of the barrios, or political units, of the municipalities are situated.

Rabel Cave, a two-entranced cave, is 167 meters long while the width at the soil floor level varies from as narrow as 2 meters to as wide as 17 meters. The ceiling of the cave is high, approximately 9 meters on the average. The cave is arbitrarily divided into 4 chambers, Chambers A, B, C and D, using natural features such as diverse floor levels, the density of limestone boulders and stalagmites, general characteristics of the surface of the soil floor area, and compass directions of the different chambers as criteria for the division. The soil floor of Rabel Cave slopes gradually downward from both entrances towards the

pitch-dark and breezy middle portion of the cave.

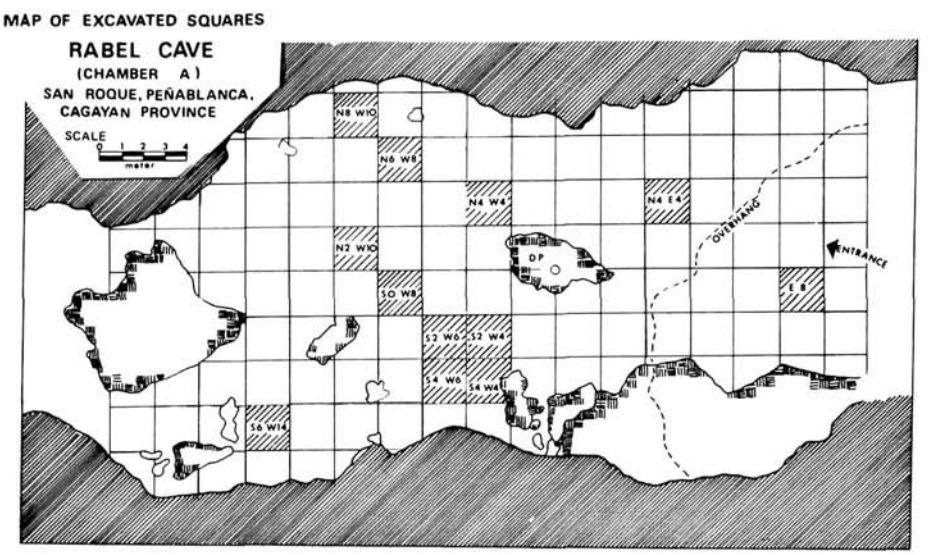
Chamber A, the area by the larger mouth of the cave, is where archaeological activities were undertaken. The mouth of the cave at Chamber A is large being 9 meters and 70 centimeters in height and 18 meters and 20 centimeters in width. With an average width of 18 meters, the ceiling of Chamber A is domeshaped and is characterized by numerous stalactites of varying sizes and shapes. The length of Chamber A is 28 meters and 30 centimeters. Its soil floor area is predominantly clay and rocks; boulders of fallen limestone stalactites and a few stalagmites were present on its surface. Chamber A is well-lighted by sunlight in the morning but becomes dimly-lighted by sunlight in the afternoon. The chamber is cool and breezy the whole day, the latter condition being due to the existence of the second smaller entrance at the other end of this long and winding cave.

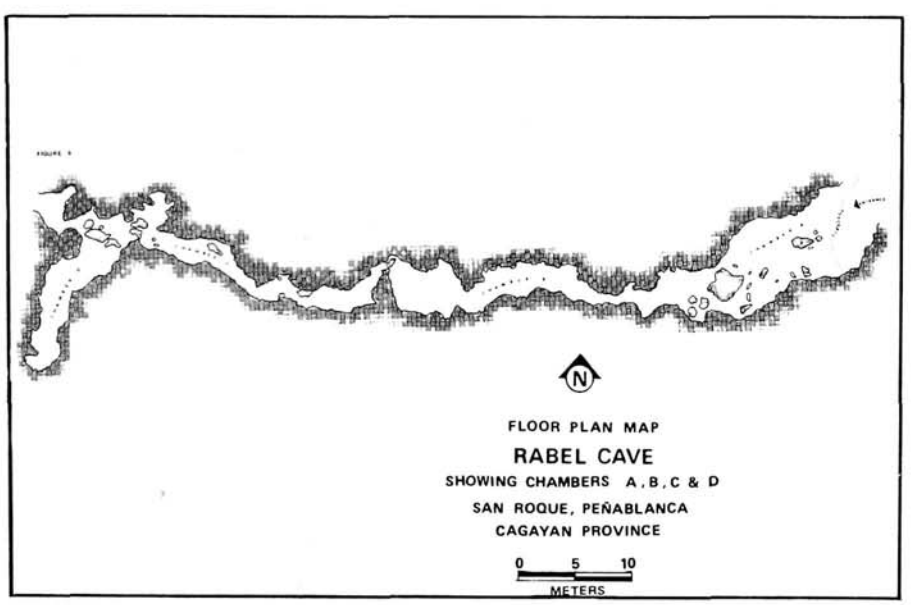
Rabel Cave was chosen for archaeological excavations primarily due to the recovery there of extraneous lithic materials, earthenware sherds, small animal bones and teeth and river shells. All these materials were found at the surface of the floor of the cave during the exploration period activities.

To quantify the technological and functional attributes of the flake tools and waste flakes from Rabel Cave, the researcher used various equipment such as a spreading caliper, a goniometer, a weighing scale and a millimeter tape. The following variables were considered in the analyses: the measurable variables of length, width, thickness, weight; diameter of the flake; angle of the bulb of percussion versus the striking platform, length of the used edge; angle of the used edge and percentage of the used edge; and the non-measurable variables such as edge shape or used edge type, degree of edge wear, and the presence or absence of the bulb of percussion, striking platform, ripples, fissures and a negative bulb.

For the measurements of the lithic flakes, Shawcross' method (1964) was followed. This method is based on the recognition of flakes having a common axis which makes the direct comparison of their proportions of length and width possible. The method avoids taking and comparing the maximum and minimum dimensions of flakes which are not necessarily along the defined axes. Shawcross notes that "the axis of the cone, radiating from the point of the impact of the blow, will be perpendicular to the striking platform" and "the existence of this axis means that the length of the flake can only be along that axis, while the breadth must be parallel to the striking platform" (Shawcross 1964:63).

The lithic materials recovered from the archaeological excavations of Rabel Cave include utilized flakes, waste flakes, chips, primary cores, cobble tools and hammerstones. Utilized flakes are pieces which exhibit the presence of several of the non-measurable varia-

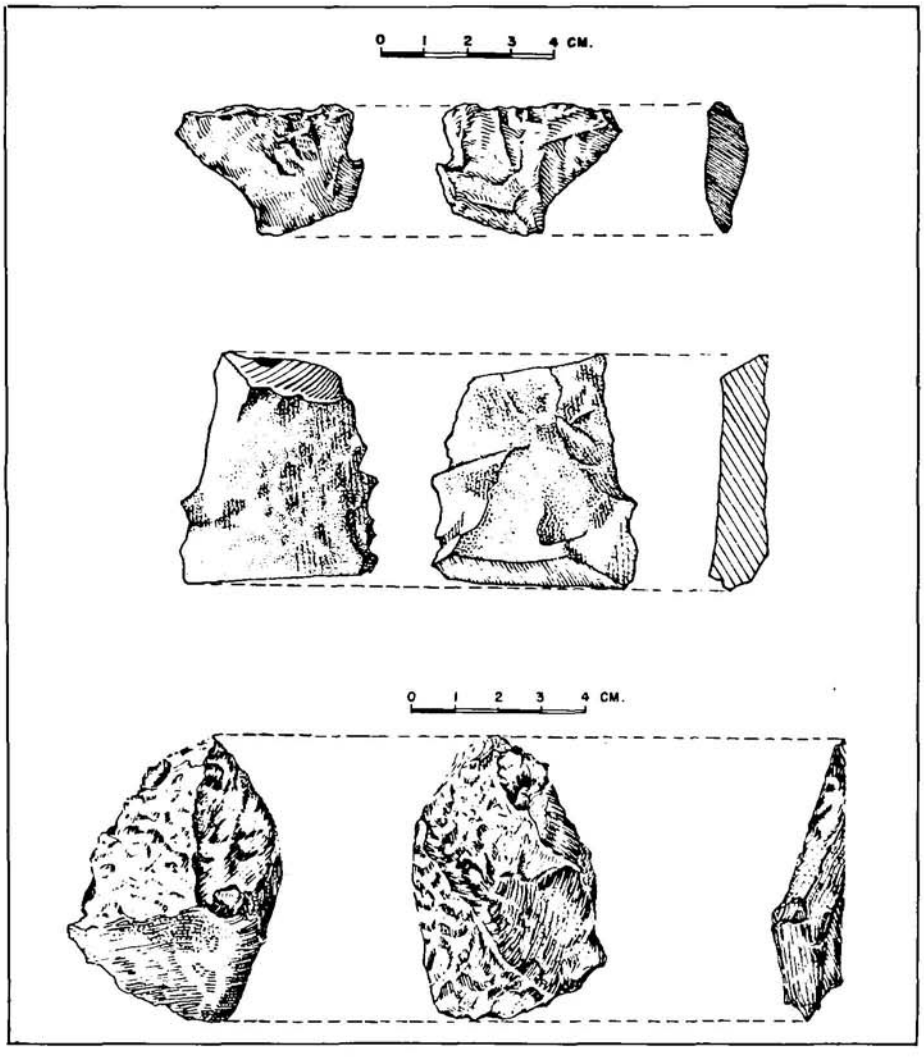




bles normally exhibited by artificially struck flakes and, more importantly, the presence of sharp and useable working edges. The sizes of the flakes, i.e., large enough to be held between index finger and the thumb with the sharp edge exposed, were also considered.

Waste flakes are lithic materials with some or most of the characteristics of an artificially struck flake except that they do not have sharp and useable working edges. The majority of the waste flakes are likewise generally smaller in size for adequate handling. Chips are very small fragments which normally fly off in the process of percussion flaking. A limited number of primary cores, chunky pieces which are remnants of chipping, were also identified. Likewise, a limited number of cobble tools - river cobbles with one end unifacially flaked to achieve a sharp edge or a point - were encountered. The hammerstones were identified by the battering marks and their ideal sizes for the purpose.

Analyses of the lithic flake tools and waste flakes entailed the identification and recording of variables and attributes which stem from artifact utilization. A total of 22 variables and attributes were used in the analyses of the utilized flake tools and each used edge of a flake was treated separately. Low-powered magnification ranging from 10 x to 40 x was used in the study. All the lithic materials recovered were placed in separate plastic bags to minimize, if not prevent, post-excavation and storage damage specifically to the utilized flake tools.



Andesite Flake Tools, Rabel Cave..

Results of The Lithic Analyses

For the purpose of the present study, the lithic materials considered in the analyses and presented in this paper are taken as a whole.

Technological Analysis. Of a total of 3,366 lithic materials recovered "in situ" from the excavations of Rabel Cave, 1,512 flake tools and waste flakes were individually measured and analyzed.

The analysis showed that two kinds of raw materials were used in the manufacture of flake tools at the site, namely, andesite and chert. There are, numerically, more flake tools, waste flakes, and chips of andesite than of chert from the analyzed lithic materials from Rabel Cave. One explanation for this disparity is that andesite, in the form of river pebbles and cobbles, is ubiquitous at the Pinacanauan River floodplain while chert, the distribution and concentration of which is not as prevalent as the andesite, therefore, seem scarce in the immediate area of the limestone formation.

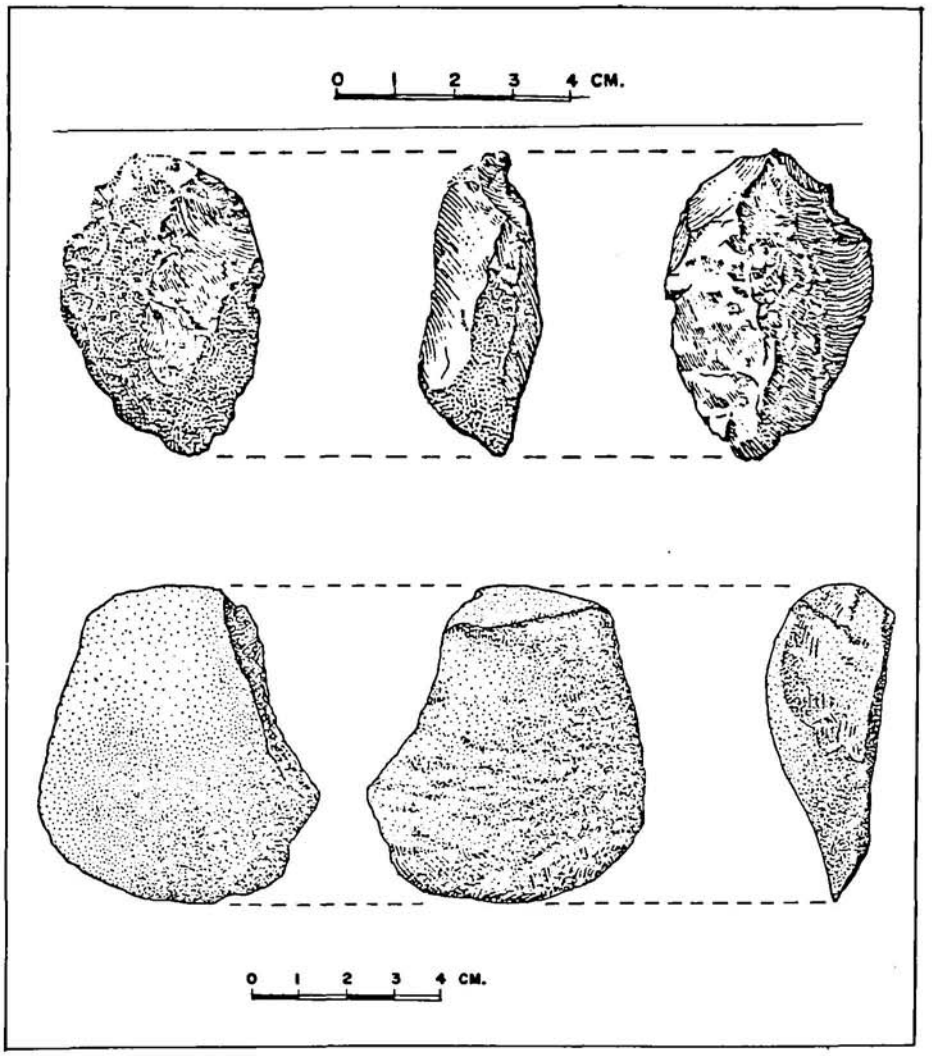
The method of manufacture of the chert and the andesite flake tools, as indicated by the tools themselves and the accompanying manufacturing debitage, is by direct percussion flaking. That there was no core preparation in the manufacture of the flake tools is indicated by the absence of regularly shaped primary cores and flakes. It was also noted that the cortex or original skin of the stone, specifically of the andesite flakes, was used as a striking platform in numerous instances, Limited replicative experiments of direct percussion flaking by the author and some members of the excavation team on andesite and chert nodules indicate that the method employed, without preparation of the core, does not predetermine the overall shape of the flakes knapped. The

recovered lithic flake tools from Rabel Cave do not show any regularity in size or shape and it is suspected that what was being sought for by the makers of the flake tools were not the forms but rather appropriate sharp edges. Ethnographic research by J Peter White in New Guinea (White and Thomas 1972) indicates that to meet the requirement of functional tools, flakes need only to fulfill the condition that they have potential working edges. Conformity to standardized overall forms by further modification was noted to be unnecessary.

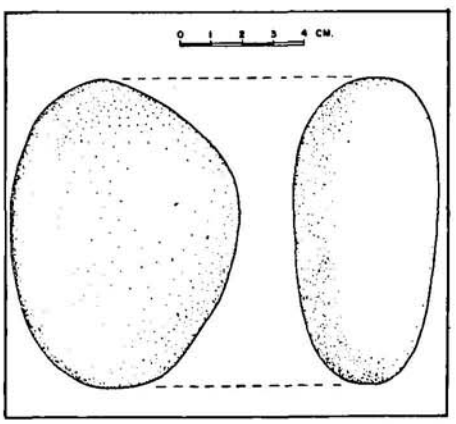
A total of 11 cobble tools were recovered from the excavations of Rabel Cave making 3.3% of the corpus of the lithic materials recovered. All the cobble tools were of andesite. The limited number of cobble tools may indicate that the andesite flake tools were the ones mainly sought for by the artisans. The numerous andesite waste flakes and chips recovered were not only due to the manufacture of the cobble tools but were mostly the by-products in the manufacture of andesite blade tools. It is noteworthy that in the manufacture of andesite cobble tools, as shown by some replicative experiments, there were flakes - possessing potential working edges and are of adequate sizes for handling - that fly off in the process of percussion and may be employed as flake tools. This may well be the case for some of the andesite flake tools recovered at Rabel Cave.

The excavations at Rabel Cave resulted in the recovery of only very few un-worked chert nodules of varying sizes. This may be an indication that preliminary modifications of the chert nodules were done outside the cave and that only the final knapping of the chert to make the tools, as shown by the numerous chert flake tools, waste flakes and chips, was done at Rabel Cave.

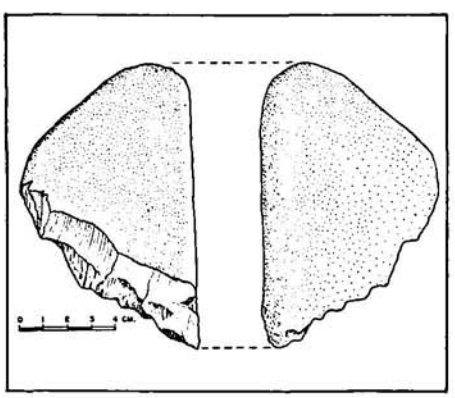
The andesite materials, however, indicate otherwise. The majority of the andesite flake tools, waste flakes and chips still retain the cortex of the nodule. This suggests that whole andesite nodules were brought to the cave and were subsequently knapped for the manufacture of both flake and cobble tools. The analysis showed that in 45.16% of the andesite flake tools the cortex of the nodule was used



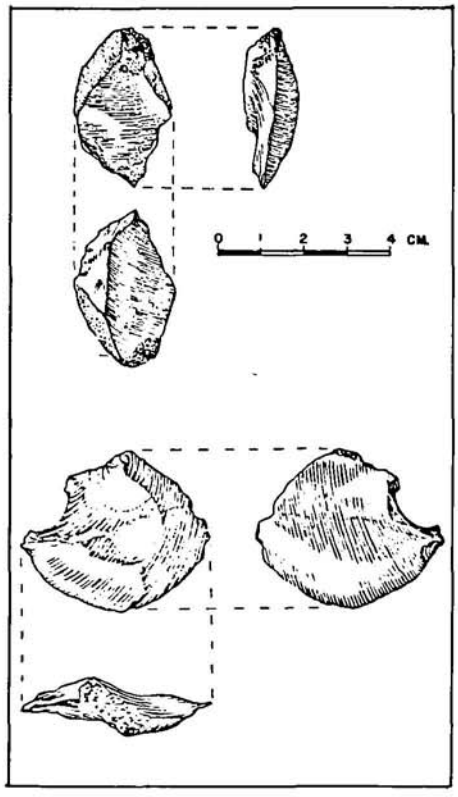
Andesite Flake Tools



Andesite Hammerstone



Andesite Unifacial Cobble Tool.



Chert Flake Tools.

as a striking platform while for chert this was observed only in 4.52%

Only 10 chert and 4 andesite primary cores were recovered from the excavations of Rabel Cave. The primary cores show no prepared striking platforms but indicate the randomness of the percussion method applied on the original nodules.

The excavations also resulted in the recovery of 4 andesite hammerstones. These hammerstones, as indicated by the battering marks on them, were the ones most likely used in the manufacture of the andesite flake and cobble tools and also of the chert flake tools. There were no hammerstones of chert recovered at Rabel Cave.

Functional Analysis. For the functional analysis of the utilized flake tools from Rabel Cave, four variables were considered for the purposes of the present study, namely:

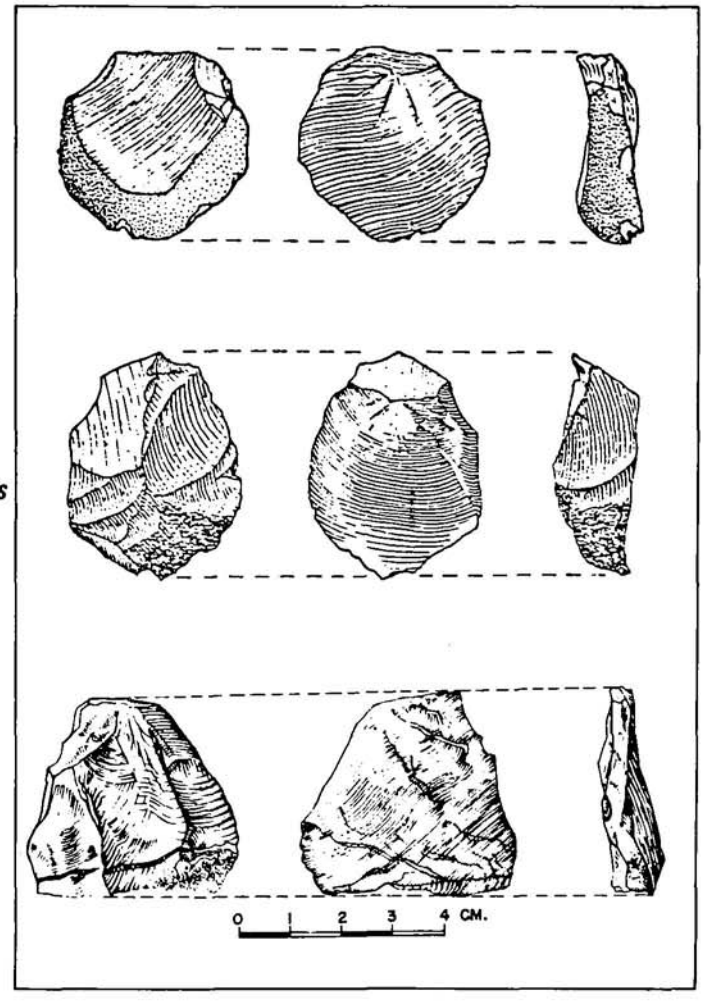
Angle of the Used Edge. Edge angle as a functionally specific variable has been indicated by ethnographic studies (Gould, Koster and Sontz 1971:49-169) and its importance has also been noted in use-wear analysis (Semenov 1964: 19-21). Wilmsen (1970:73) has also suggested that different angle sizes of flake tools are related to different functions.

Regarding the edge angles of the utilized flakes from Rabel Cave, it is noted that the highest number of the andesite utilized flake tools (33.90%) had an angle between 30 - 39 while the highest number of the chert utilized flake tools (30.66%) had an angle between 40 - 49.

The majority of the utilized flake tools can be seen to fall between the angles of 30 - 59, 73.58% for chert and 81.48% for andesite. Following Wilmsen (1970:70-71), this would make the utilized flake tools, both of chert and of andesite, at Rabel Cave ideal for "cutting, skinning, hide scraping, sinew and plant fiber shredding, heavy cutting of wood, bone or horn and tool back blunting".

Edge Shape or Used Edge Type. It has been noted (Tainter 1979:465) that "certain edge shapes are more suitable for some tasks. In butchering, corners and straight-to-convex edges are preferred". Gould, Koster and Sontz (ibid.) have also observed that concave edges were often the results of woodworking.

With regards to the used edge type of the utilized flake tools analyzed, the edge shapes of the majority of the tools - 70.76% for chert and 68.66% for andesite - were almost equally divided between straight and convex edges. Following Tainter (ibid.), the data



Chert Flake Tools

suggest that the utilized flake tools analyzed were ideal for butchering. Only a minimum number of utilized flakes - 12. 74% for chert and 11.68% for andesite - were concave-edged, making them ideal for woodworking.

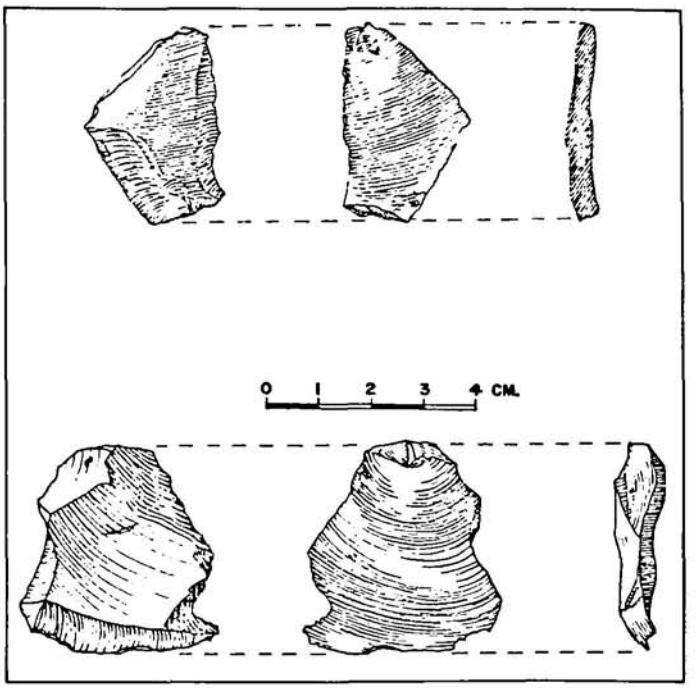
Degree of Edge Wear. The degree of edge wear was seen as patterns of modification of edges resulting directly from use. It is, thus, more important for utilized flakes than for retouched flake tools since the wear recorded in the former was not altered by subsequent retouching. The raw materials of the utilized flake tools were considered to be important factors during the analysis of this variable.

The majority of the utilized flake tools - 93.40% for chert and 94.58% for andesite - showed slight and moderate degress of edge wear. In over 60% of the chert and andesite flake tools, the degree of edge wear was slight.

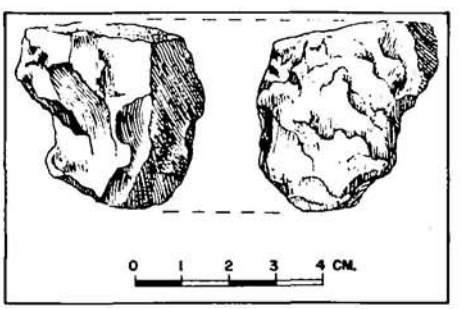
It has been noted in recent experimental results regarding stone tools (Walker 1978:710-15) that for most butchering tasks the flakes with unworked edges were more efficient for the job than flakes with retouched edges. Results of experiments by Brose (1975) have also indicated that unretouched flakes do not last longer than four minutes of use in butchering activities suggesting that at sites where butchering activities took place, there will be a high density of stone tools. The high incidence of utilized flake tools of both chert and andesite at Rabel Cave - the majority of which showing slight and moderate degrees of edge wear - and the associated faunal bones and teeth of birds, bats, monkeys and pigs recovered from the excavations suggest the possibility of butchering activities at the site.

Percentage of the Used Edge. The lengths of the used edges and the diameters of the utilized flake tools were noted and recorded, and subsequently, the percentage of the used edges were computed from these two variables. In the majority of the utilized flake tools, 81-60% for chert and 76.64% for andesite, the used edges occur between 10% and 39.9% of the total tool size. Although this variable has not been considered in works on lithic use-wear analyses, it may well be useful, together with ethnographic analogy and replicative experiments, in ascertaining the manner in which flake tools were handled by their users.

Chert Flake Tools



Chert Primary Core



Discussion and Interpetation

The results of both the technological and functional analyses employed on the lithic materials recovered from the archaeological excavations of Rabel Cave have shown different aspects important for the understanding of the original inhabitants of Rabel Cave with regards to both their skill in the manufacture of the lithic tools and also the probable uses of the lithic flake tools that they manufactured.

The technological analysis has shown the different methods employed by the knappers in the preliminary modification of the lithic materials. For chert, preliminary modification was done outside the cave while for andesite, this modification was done right at the cave. This was indicated by the difference in the andesite and chert utilized flake tools and waste flakes - with the cortex or portions of it still present on the dorsal surface of the andesite tools - and the density of unworked nodules

present at the site. There were very few unworked nodules of chert as contrasted to numerous unworked nodules of andesite. The absence of regularly shaped primary cores and flakes of both chert and andesite indicates no core preparation in the manufacture of the flake tools.

The functional analysis of the lithic flake tools from Rabel Cave shows that, with regards to edge shape, two types - both straight-edge and convex-edged - were sought for by the knappers. The majority of the utilized flake tools are seen to be ideal for butchering and a minimum number, being concave-edged, are ideal for woodworking.

In Southeast Asia, there is a limited amount of work done on edge damage analysis (Gorman 1970; Hutterer 1974; Peterson 1974), the results of which suggest the prevalence of the woodworking functions of lithic flake tools. These give credence to the postulate that the lithic flake tools in Southeast Asia were complemented by a number of non-lithic and, therefore, perishable materials such as bamboo and wood (Solheim 1970; van Heekeren 1972). This maintenance role of lithic flake tools has also been documented ethnographically and archaeologically (White 1969, 1972; White and Thomas 1972; Gorman 1971).

The edge angles of the majority of the utilized flake tools analyzed fall between 30 - 59 for both chert and andesite, thus, making them ideal for a number of tasks. They may, therefore, be considered as generalized maintenance tools.

The slight to moderate degrees of edge wear on the used edges of the utilized flake tools analyzed and also the high incidence of tools at the cave site again suggest, following experimental results by Brose (1975), the possibility of butchering activities at the site. This is reinforced by the faunal bones and teeth of birds, bats, monkeys and pigs directly associated with the lithic materials.

...the lithic flake tools in Southeast Asia were com plemented by non-lithic and perishable materials...

The percentage of the used edge of the utilized flake tools, the majority of which occur between 10% and 39.9% of the total diameter of the tool, may be an indication of the non-hafted characteristic of the tools. This assertion is also supported by the presence of negative bulbs of percussion on the dorsal surfaces of the tools, thus making them adequate for handling, noted in numerous utilized flake tools analyzed. The results of the analyses of the lithic flake tools from Rabel Cave indicate that:

1. In technological terms, the technology of tool manufacture was almost, if not, identical for both chert and andesite; i.e., involving a percussion method and without any core preparation. The main difference shown by the results of the technological analysis was that the preliminary modifications of the andesite nodules were done right at the cave while that of chert nodules were done outside the cave. For both raw materials, the production of flake tools was the main object of the knappers.

2. In functional terms, the analysis has shown the generalized characteristic of the utilized flake tools thus making them ideal for a number of different tasks. The data from the results of the functional analysis give credence to the hypothesis that the utilized flake tools recovered from Rabel Cave are maintenance tools.

Bibliography

Bordaz, Jacques
1970 ***Tool of the Old and New Stone Age,*** The Natural History Press Garden City, New York.

Brose, David S.
1975 Functional Analysis of Stone Tools: A Cautionary Note of the Tole of Animal Fats, in ***American Antiquity,*** Vol. 40, No.1, January, 1975. 86-94.

Corby, G.W.
1951 Geology and Oil Possibilities of the Philippines, Department of Agriculture and Natural Resources Technical Bulletin No. 21. Manila.

Crabtree, Don E.
1970 Flaking Stone Tools with Wooden Implements, in ***Science*** 169(394): 146-153.

Crabtree, Don E.
1973 The Flintknapper's Raw Materials, in ***In Search of Man,*** Ernestene L. Green, editor. pp. 230-234. Little, Brown and Co.

Crabtree, Don E. and E.L. Davis
1968 Experimental Manufacture of Wooden Implements with Tools of Flaked Stones, in ***Science*** 159(3813): 426-428.

Curwen, E. Cecil
1935 Agriculture and the Flint Sickle in Palestine, in ***Antiquity,*** Vol. 9, No. 33, pp. 62-68.

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