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A RE-INVESTIGATION OF THE ESPINOSA ARCHAEOLOGICAL SITES IN CAGAYAN AND KALINGA-APAYAO

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Field investigation was conducted from June to August of 1979 to verify the stratigraphic cross section of the Espinosa Ranch Archaeological Sites, locality 4, made in 1971. The re-investigation also included work to show the relation of locality 4 to locality 1. The discoveries since 1971 of extinct Pleistocene fossil remains of ancient mammals all confirm the geological theory that the Philippines was linked by land bridges to mainland Asia in prehistoric times. Results of the investigations include two recovered utilized flake tools in the new grid system, retrieved in-situ *and imbedded in a fine argillaceous sandstone bed mapped as belonging to the Awidon Mesa Formation and therefore of Pleistocene Age deposition. Also recovered are elephant bone fossils in a tuffaceous claystone member of the same formation.*

Introduction

Since 1971, the Philippine National Museum has been engaged in significant archaeological research in Cagayan Valley, Northern Luzon. The discoveries of extinct Pleistocene fossil remains of ancient mammals, e.g., elephant, stegodon, rhinoceros, etc., all confirm the geological theory that the Philippines was linked by land bridges to mainland Asia in prehistoric times (See Fig. 1). Also significant is the discovery of man-made cobble and flake tools associated with these fossils. We are therefore convinced of the prospect of discovering human fossils that would explain the association between the discovered tools and ancient animals. These initial discoveries have increased and focused the interest of the National Museum researchers in their search of the ancient man in the archipelago, particularly in the Cagayan Valley.

Systematic diggings were then undertaken extensively, particularly in the Espinosa and Madrigal ranches, two adjacent sites where these artifacts and ecofacts are in association. The most significant finds were the discovery of two flake scrapes in the Espinosa, locality 4 and one man-made waste flake in Espinosa, locality 1 Cagayan. These stone tools as reported by Dr. Robert Fox, a former curator of the National Museum and one of the pioneers of archaeological research in the country, were retrieved *in situ* from the Awidon Mesa Formation in which they were embedded. The said information is a sedimentary stratigraphic member in the valley basin, tentatively dated Pleistocene (Durkee and Peterson, 1961). It is logical to infer from these findings that man existed in the Philippines since Pleistocene time. To be certain that this inference is unquestionably reliable, stratigraphy of the sites must be carefully mapped and corresponding age of the formation which the artifacts were retrieved *in situ* must be definitely established. If this is achieved, then the discovery of human fossil, while it would be confirmatory, would not be absolutely necessary to prove the existence of man in the archipelago during the pre-historic time.

Upon the instruction of Dr. Jesus Peralta, curator of the National Museum and a leading researcher in the Espinosa sites, a verification was made of the stratigraphic cross section of the Espinosa Ranch Archaeological Sites, locality 4, made in 1971 by Mr. Silvio Lopez, a former geologist of the National Museum.

This investigation also included work to show the relation of locality 4 to locality 1 which was excavated partly by a Japanese archaeologist, Yogi Aoyagi.

Field investigation was conducted from June 22 – August 19, 1979, inclusive, by a group composed of Messrs. Maharlika Cuevas and Roger Espiritu, technicians; Mr. Eduardo Bersamira, scientific illustrator; and this writer as head.

Description of the Area

The investigated sites are located on grassy hills and knolls on the western side of Cagayan Valley. Extensive erosion has shaped the area into rolling hills now almost treeless because of "kaingin," a common practice of the local people of burning the vegetation just before the rainy season to produce young grasses for grazing or to make the soil more fertile for agricultural purposes.

The area is specifically located on the east flank of the Pangul anticline and near the south nose of another big, Northern-Southern trending anticline, the Cabalwan, on which many archaeological sites have been located including the fossil site excavated by the team of Mr. Melchor Aguilera in June 1979. To the west beyond the Pangul anticline is the plateau of Tabuk through which the Chico River cuts its way to the sea. Like this river, the other drainage lines in the area are largely consequent streams with some subsequent streams also parallel to the strike of the anticlines (Wasson and Cochrane, Jan. 1979).

The barrios located nearest to the sites are: Nabbutuan and Pallao, Solana, Cagayan only 2.5 kms. to the east; and Macutay, Rizal Kalinga-Apayao, to the Southeast. Rizal town is about 34 kms. road distance to the west from Tuguegarao, Capital of Cagayan province, which may be reached from Manila through 488 kms. of the Maharlika Highway (formerly, Pan-American Highway) by Pantranco or P.N.R. buses with several trips available any day, or by one hour P.A.L. flight.

The site itself may be reached by either one of two routes from Tuguegarao, namely: 1) By bus to Rizal, then through 8 kms. of dirt road up to Macutay, Rizal and 2.5 kms. of foot trail; and 2) through the Gadu route passing through several barrios of Solana, Cagayan by jeepney up to barrio Nabbutuan, then on foot through 2.5 km. of dirt road to the site because the bridge crossing the Andaravan creek collapsed a few years ago and has not been repaired since. The residents in the surrounding barrios are mostly Ilocanos and Tagalogs with some Itawes and Kalinga minorities.

Climate

The wet season of the Cagayan Valley as a whole is not very pronounced and lasts from May to December. The short dry season lasts from January to April. A large proportion of the rainfall during the period occurs in the western margin of the valley because of its high elevation and closeness to the Cordillera Central. Typhoons also cross the area during the period especially from July to October but they are seldom very destructive because of the mountain shields from the east, south and west.

Geology

The Cagayan Valley basin in which the sites are located is bordered by high mountains in the east, south and west, namely the Sierra Madre, Caraballo, and the Cordillera Central, respectively, and by the Babuyan channel in the north. The mountain borders are composed of metasediments and basaltic and andesitic rocks of volcanic origin (Durkee and Peterson, 1961; and other workers). These rocks constitute the basement of the basin formed as deeply subsiding marine trough during the Oligocene. The basement is overlain by 10,000 meters of Oligocene and Miocene sediments and by 400 to 2,000 meters of Pliocene transitional marine and fluvial sands of the Ilagan Formation (Corby, et al., 1951;

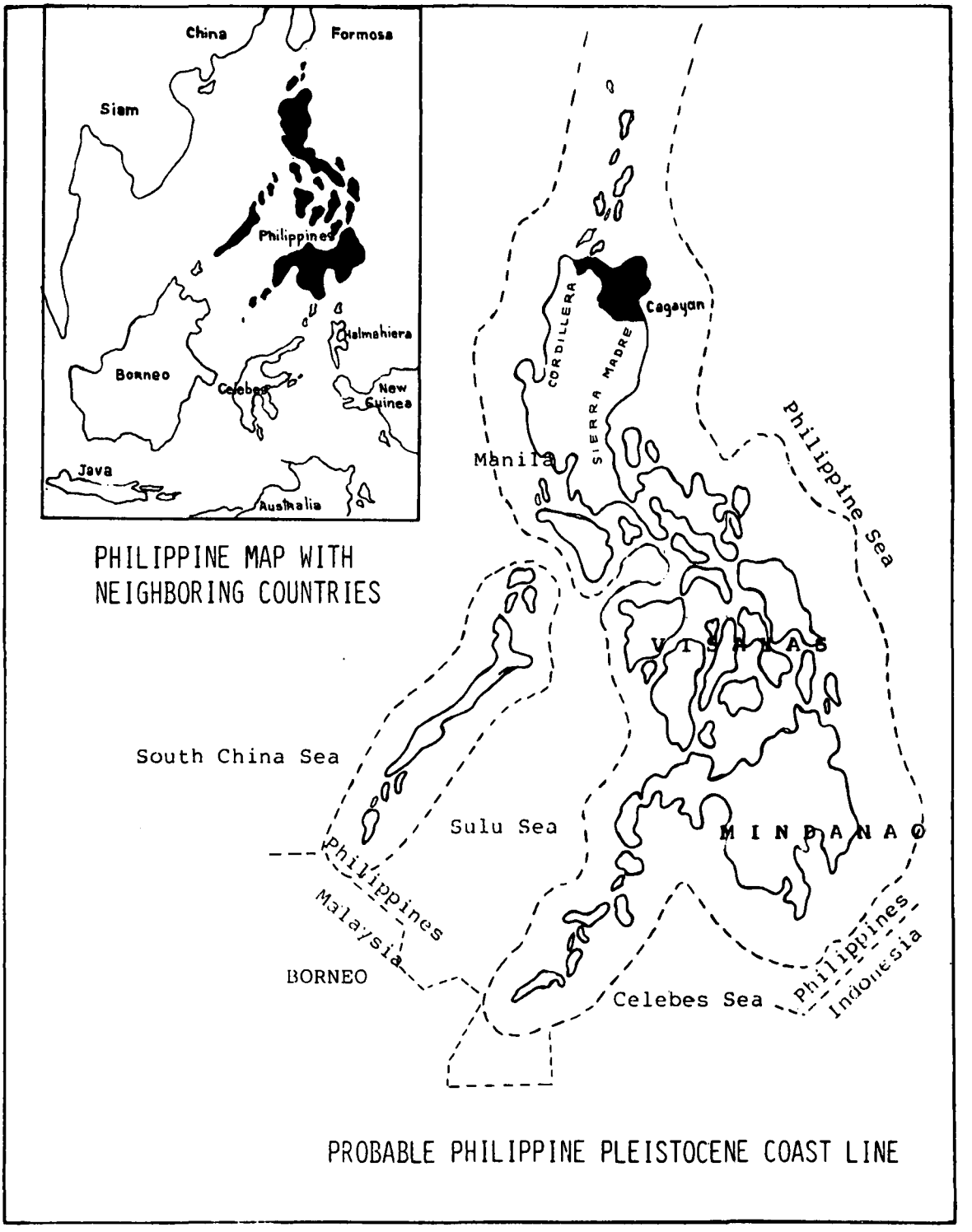

China
Formosa
Siam
Philippines
Halmahiera
Borneo
Celebes
New Guinea
Java
Australia
PHILIPPINE MAP WITH
NEIGHBORING COUNTRIES
CORDILLERA
SIERRA MADRE
Cagayan
Manila
Philippine Sea
V I S A Y A S
South China Sea
Sulu Sea
M I N D A N A O
Philippines
Malaysia
BORNEO
Celebes Sea
Philippines
Indonesia
PROBABLE PHILIPPINE PLEISTOCENE COAST LINE

FIG. 1

Durkee and Peterson, 1961; Tamesis, 1976). Conformably overlying the Ilagan Formation is a 300 meter series of Pleistocene tuffaceous fluvial sediments of the Awidon Mesa Formation (Durkee and Peterson, 1961).

The Espisona sites are within the Awidon Mesa Formation. As established by previous workers, this formation is composed of tuffaceous sediments derived from a dacitic source which are characterized by the presence of bipyramidal quarts (generally less than 5%), enhedra of hornblende and sodic feldspar (Vondra & Mathisen, 1978). The Awidon Mesa Formation is very fossiliferous compared to the Ilagan Formation. Although the former was found to be immediately younger (Pleistocene?) than the latter (Pliocene), the ages of the two formations are still tentative until fixed by radiometric dating being worked out by geologists from Iowa State University, U.S.A. Moreover, the contact relationship between the two formation changes from comformable in the valley to uncomformable in the mountains which indicates that the Cagayan Valley anticlinal belt of large anticlines along the western margin of the valley must have been folded during the Pleistocene (Vondra & Mathisen, 1978).

The area is within the central part of the anticlinal belt, two of which are noteworthy, namely, the Pangul and the Babalwan anticlines. In order to understand the behavior of the intersecting east flank of the Pangul anticline and the Cabalwan anticline, a reconnaissance survey was undertaken before the detailed stratigraphy of localities 4 and 1 of Espinosa Ranch was studied. Wasson, an Australian geomorphologist, states in his report that the Espinosa sites are within the Cabalwan anticline while Mark Mathisen, a Quaternary geologist from Iowa State University who conducted a detailed survey of the area, particularly of the Ilagan and Awidon Mesa Formations, observes that it is still a part of the east flank of the Pangul anticline. Because of the southward plunging behavior of the Cabalwan anticline the sites are considered in this report in accordance with the Mathisen observation. It is very close, however, to the intersection of the south nose of the Cabalwan anticline with the east flank of the Pangul anticline (See Fig. 2).

The Pangul anticline has the greatest relief up to 350 meters while the Cabalwan is a smaller feature with a maximum relief of 150 meters. The axis of the Pangul anticline trends NN-W or SS-E with the western flank dipping between 10° and 52° to the SW, and the eastern flank, where the archaeological sites are located, dipping about 6° N, 72°E.

Mapping the Site

The northeastern corner of the house of the late Mr. Daniel Espinosa was chosen as the primary datum point for all the locality sites within the Espinosa and Madrigal ranches. Corresponding local datum point (LDP) was also set and conveniently located for each locality site to ease archaeological mapping. These bench marks were all established by the geology division of the National Museum.

Locality 4, Espinosa Ranch

This site is N 4°E and 298.5 meters away from the datum point. It is a small hill halfly dissected by a gully trending to the North.

A contour map of the site was prepared using the Jacob's staff method (See Fig. 3). This is a simple way of contour mapping whenever the bulky set of alidade and plane table is not available. This procedure employed a 50-m tape, Brunton compass and a rod 1.5 m. long and especially prepared to have a wide flat top and graduated in 10 cms. interval from the bottom.

Before starting the actual setting of contour points, a reconnaisance over the whole area was made to roughly determine the points to be occupied which determine the contour line. The points were selected along the different slope profiles of the surface at approximately 1.5 m. vertical

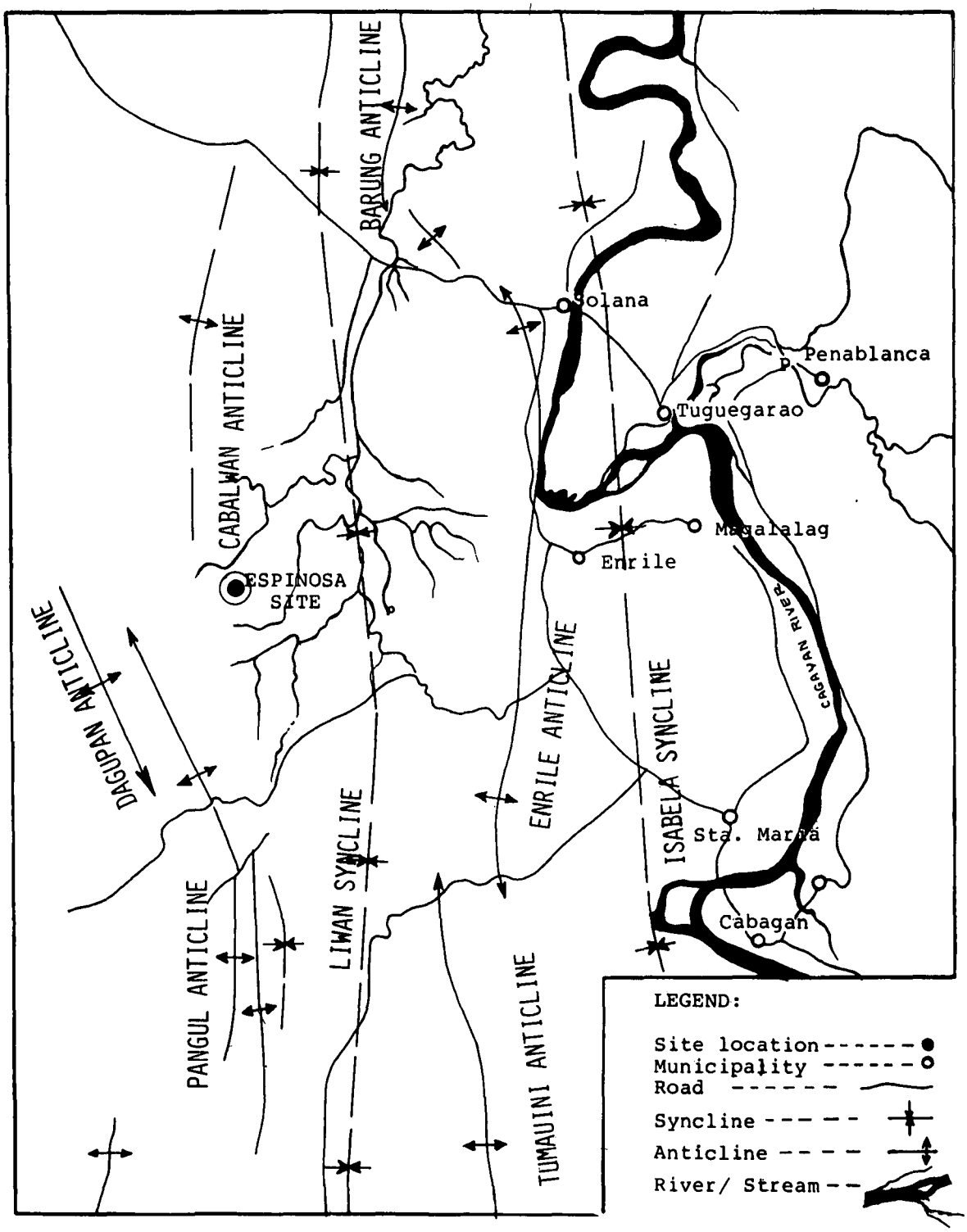


FIG. 2
SITE LOCATION

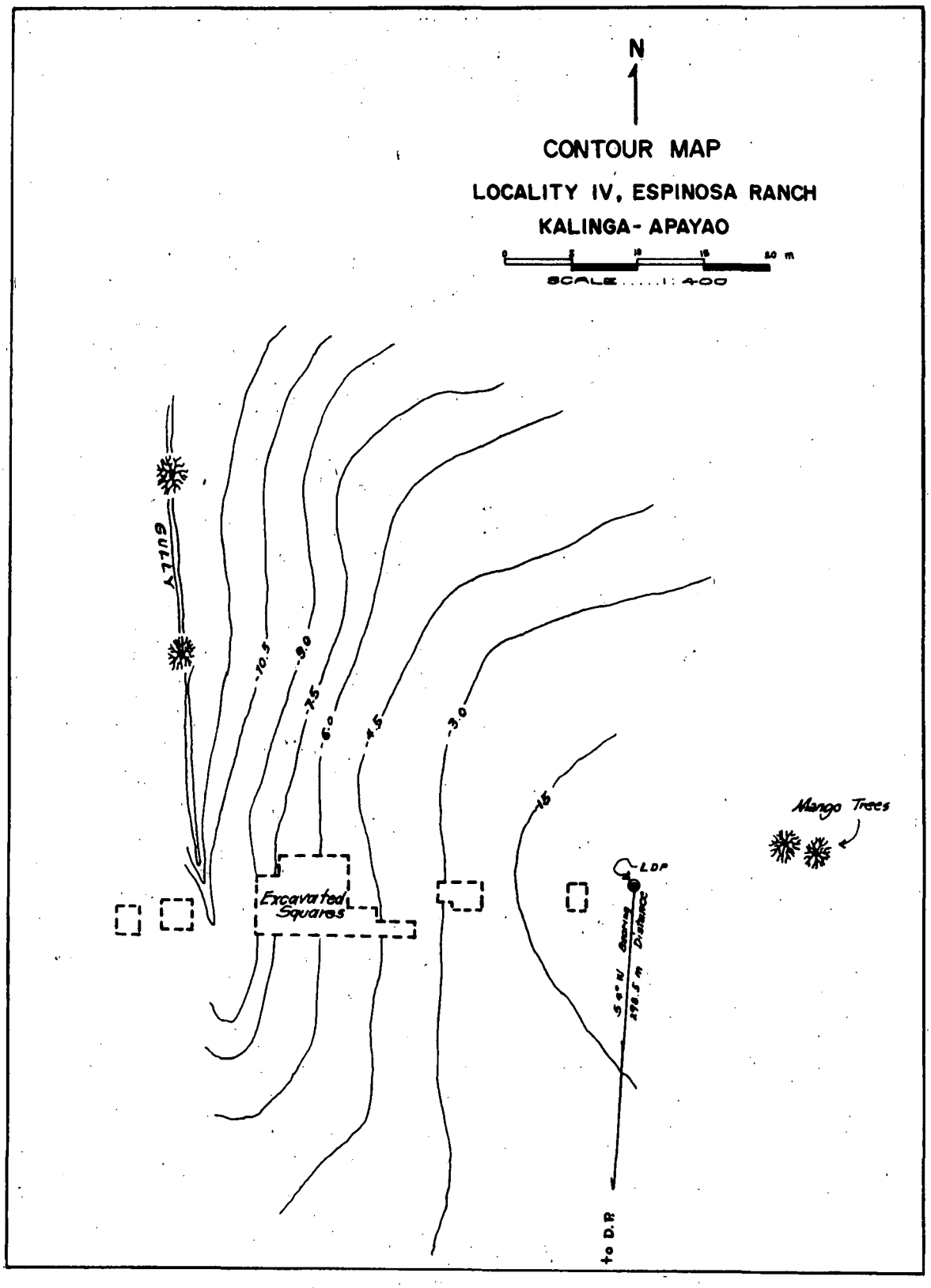

N
CONTOUR MAP
LOCALITY IV, ESPINOSA RANCH
KALINGA- APAYAO
SCALE 1: 400
GULLY
10.5
9.0
7.5
6.0
4.5
3.0
1.5
Excavated Squares
LDP
Mango Trees
to D.R.

FIG. 3

distance interval downward from the LDP previously established. When this was done, the first contour line was established as follows: the rod was set at about the points previously selected moving it to different points up or down until it was set at a point exactly 1.5 meters vertical distance from the LDP. This was done by using the clinometer level of the compass which is set on the well levelled top of the rod by sighting and making sure that the datum plane coincide with the sight of the compass. The bearing of each point occupied with reference to the LDP was taken, recorded and plotted. The line connecting the points plotted is the first contour line. The other contour lines were established in a similar way, but this time any point already established along the first contour line was used as reference point.

The Trench Profile

The excavation is a stair-like trench 44 m. long and 4 m. wide. Since the site is a part of the eastern flank of the Pangul anticline which is striking N 18°W and dipping 6°, N72°E approximately, the stratigraphic cross section of the trench is taken from the datum point, east to west. The face was completely scraped of slope wash, grasses and weathered surfaces which might alter or blur the stratigraphy. Each layer was examined noting information on the texture which denotes particle size regardless of mineral composition, the maximum and minimum thickness of bed, and degree of induration, and remarks whether each constituent of the deposit is a primary or secondary deposition. The stratigraphy of the excavated squares of locality 4, Espinosa Ranch is summarized in tabulated form. (See Tables 1 & 2).

Results of the Investigations

1) The stratigraphic profile on the south wall of locality 4, Espinosa Ranch Kalinga-Apayao is shown. (See Fig. 5,6,7).

2) The two recovered utilized flake tools in square SW7 or square SW301 in the new grid system, appear to be *in-situ*, embedded in fine argillaceous sandstone mapped as belonging to the Awidon Mesa Formation (Vondra & Mathisen, 1978) and possibly of Pleistocene Age deposition. The point of recovery is 83 cms. from the surface or 3.13 m. from the datum plane. The argillaceous character of the enclosing bed at the site and immediate vicinity of deposition of the flake tools might cast suspicion that the sediments and the tools are of only recent deposition that is very much younger than the surrounding Awidon Mesa Formation. However, upon close examination of the continuity of the bed to the north wall of square SW301 (SW7) the lithology was noted to grade to sandstone with less clay content. This writer therefore believes that the enclosing bed originally was approximately of the same composition with those immediate surrounding, laterally and below, that is of fine sandstone, but because of erosion of overlying sediments the colloidal clay particles carried in water seepage percolated downward into the porous sandstone and deposited therein making that portion argillaceous. The artifacts could not have been carried, transported and deposited by water (sorting action of gravity and water would not make them possible to be deposited with the very fine sediments) but laid or dropped by the users at the time and place of deposition of the enclosing primary sediments.

Underlying the fine grained argillaceous sandstone immediately below the tool – enclosing bed is a silty, tuffaceous claystone easily recognized by the presence of gossan, a band of yellow to reddish deposit of hydrated oxides of iron. Unconsolidated soil with the traditional humus substance of organic origin overlies the artifact bearing bed. The soil color is brownish to dull black with high carbon content (52 – 58%).

3) Also noted were elephant bone fossils embedded in tuffaceous claystone member of the same Formation but much lower than the bed containing the flake tools. Almost the

LAYER	SOIL CLASSIFICATION	MUNSELL COLOR CODE	MINERAL COMP.	DEGREE OF INDURATION	BASAL CONTACT	THICKNESS Maximum (cm) Minimum	REMARKS
1	Humus	Brownish black	Carbon clay minerals	Friable	Merging	10 cms. (Approximate)	Recent deposition
2	Fine argillaceous sandstone	Very pale brown Hue 10YR 7/4	Clay mineral tuffaceous; absence of black mineral.	Slightly indurated	Sharp	80 52	Secondary deposition of an accessory amount of clay.
3	Tuffaceous siltstone to mudstone	Very pale brown Hue 10YR 8/4	Volcanic ash clay minerals	Slightly indurated	Merging	52 36	Primary deposit; color and greater amount of tuff differentiate it from the lower layer.
4	Tuffaceous siltstone (coarse)	Yellow Hue 10YR 7/6	Volcanic ash quartz, clay minerals	Slightly indurated	Merging	96 76	Primary deposit with fine sandstone lens.
5A	Fine tuffaceous sandstone	Very pale brown Hue 10YR 7/4	Minerals, quartz feldspar	Poorly indurated	Merging	70 52	Primary deposit
5B	Very fine tuffaceous sandstone	Light yellowish brown Hue 2.5Y 6/4	Hornblende ash	Poorly indurated	Sharp	70 52	Coarse siltstone block above tuffaceous mudstone (layer 6)
6	Tuffaceous claystone	Very pale brown Hue 10YR 7/3	Clay mineral with volcanic ash	Compact	Sharp	76 32	Primary deposit; layer where elephant bones were embedded.
7A	Medium to fine sandstone	Light yellowish Hue 10YR 6/4	Quartz hornblende feldspar	Very poorly indurated.	Merging		Primary deposit; coarser grain at the bottom then grades up to finer particle.
7B	Medium grained sandstone	Yellowish brown Hue 10YR 5/4	Quartz feldspar ferromagnesian about 35%	Very poorly indurated			

TABLE I: Stratigraphy of Squares SW501, SW551, and SW601 (Southwall) Locality 4, Espinosa Ranch, Kalinga-Apayao.

Note: Analyzed under moist state.

LAYER	SOIL CLASSIFICATION	MUNSELL COLOR/CODE	MINERAL COMPOSITION	DEGREE OF INDURATION	BASAL CONTACT	THICKNESS (cm) MAX./Minimum	REMARKS
1	Humus	Brownish black	Carbon clay minerals.	Friable	Merging	10 cms (approx.)	
2	Fine argellaceous sandstone	Very pale brown Hue 10YR 7/4	Quartz, clay minerals	Slightly indurated	Merging	88 20	Secondary deposition of clay particles.
3	Tuffaceous claystone	Very pale brown Hue 10YR 7/3	Volcanic ash, clay minerals.	Compact	Sharp	108 80	With lens of fine sandstone
4	Very fine sandstone	Yellow Hue 10YR 7/6	Quartz, tuffaceous clay minerals	Poorly indurated	Sharp	12 24	Primary deposit, with lens of tuffaceous claystone
5	Tuffaceous claystone	Very pale brown Hue 10YR 7/3	Tuffaceous clay minerals	Compact	Sharp	28 15	Primary deposit
6	Tuffaceous siltstone	Yellow Hue 10YR 7/6	Tuffaceous clay minerals	Poorly indurated	Sharp	12 6	Primary deposit, coarse siltstone
7	Tuffaceous claystone	Very pale brown Hue 10YR 7/3	Volcanic ash clay minerals	Compact	Sharp	61 38	Primary deposit
8	Very fine sandstone	Yellow Hue 10YR 7/6	Quartz tuffaceous	Poorly indurated	Sharp	42 28	Primary deposit
9	Tuffaceous claystone	Very pale brown Hue 10YR 7/3	Volcanic ash clay minerals	Compact	Sharp		Primary deposit

Table 2: Stratigraphy of Square SW301 (South Wall)
Locality 4, Espinosa Ranch, Kalinga-Apayao
Note: Analyzed under moist state.

entire bone framework of the elephant body were found intact indicating either a) that the entire body might have floated dead with its flesh and organs still intact providing buoyancy for sometime until lost and the body deposited at this site which might have been a flood plain at the time, or b) the body might had been killed right in, or near, this place of deposition.

The fossil bones* as uncovered were fragile probably because of repeated extreme changes of temperature, humidity, ground acidity, and other weathering and erosional agents. Another reason is that the bones are not silicified nor calcified, they have been embedded in a tuffaceous claystone deposited at a time and place that not much silica or carbonate was available to harden them.

The elephant fossil bearing bed which is 55 cm. thick is underlain by 11 meters thick of poorly indurated sandstone that can be traced to the opposite hill, 50 meters to the west (Refer to stratigraphic profile of locality 4 and columnar section), and is overlain by another sandstone member, finer and thinner than that which underlies it.

4) The mere fact that both flake tools and elephant fossil were found in this same place and formation cannot be used reliably to prove conclusively the theory that locality 4 was a "kill site" of elephant. Nor could we infer that the same flake tools were used on the animal. The deposition of the latter was relatively much earlier than the former.

5) The stratigraphic relation of locality 4 to locality 1, Espinosa sites, which is represented in columnar section (Fig. 4), clearly shows that locality 4 was very much earlier in deposition than locality 1. The eleven meter – thick sandstone in locality 4, is a channel sand that cuts into sequence of tuffaceous claystone, sandstone and siltstone or changes laterally S18°W to siltstone in locality 1. Approximately twenty three (23) meters above the siltstone is the point where the waste flake was recovered in a tuffaceous siltstone, at a depth of 183 cms. from the surface in Sq. NE 967.

Summary and Conclusion

As found by previous workers, this present team has verified the following:

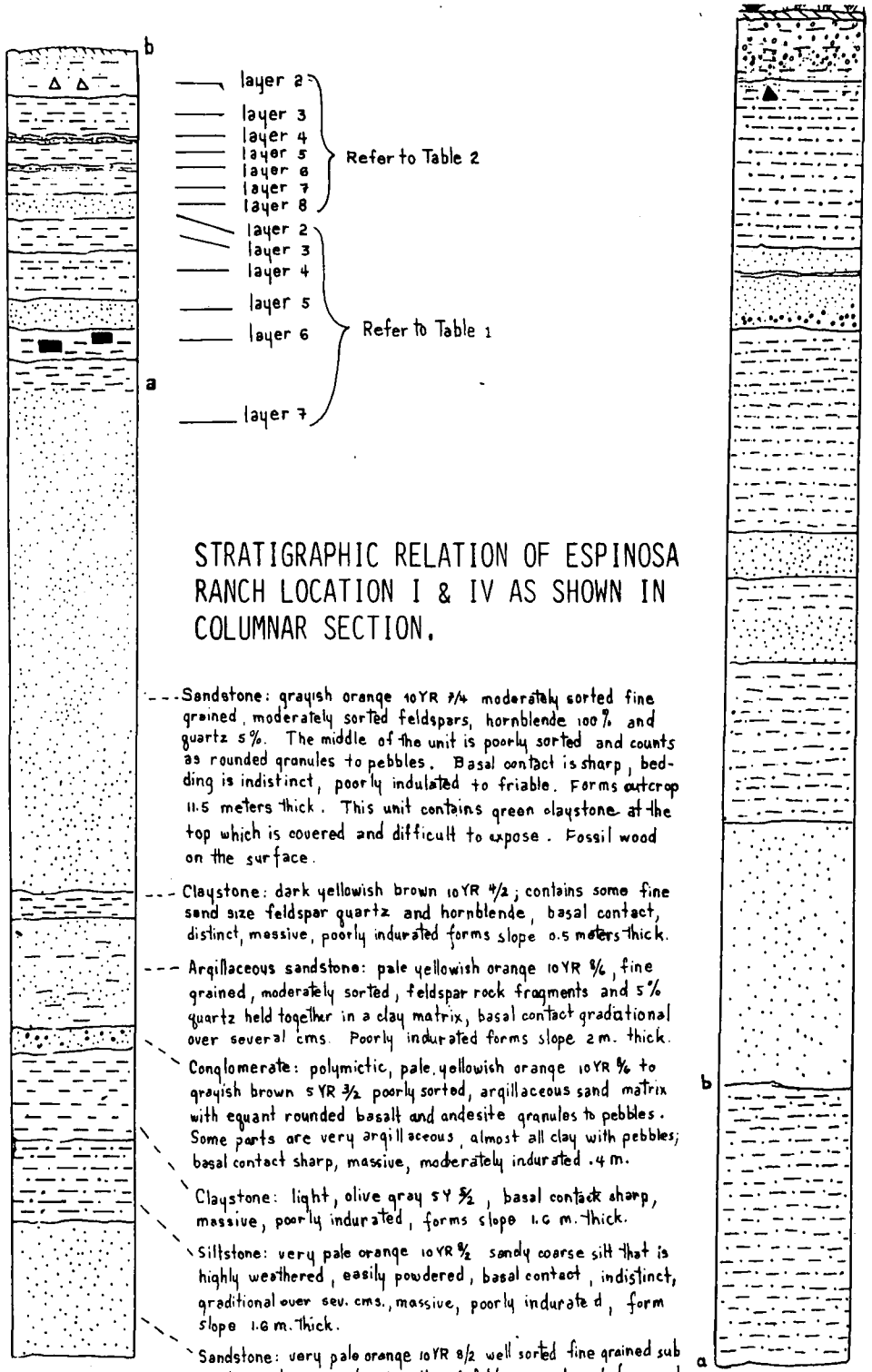
1) The occurence of two utilized flake scrapers in a previous excavation in locality 4, Espinosa Ranch. They were retrieved *in-situ,* embedded in a fine argillaceous sandstone bed which, otherwise would be plain fine – grained sandstone like those of the immediate vicinity, laterally and beneath, were it not for secondary deposition of clay from the surface.

2) The recovery of elephant bone fossils, almost intact, and *in-situ* in a tuffaceous claystone member of the same formation but much lower than the bed containing the flake tools by 4.5 meters bed thickness; in terms of time it would mean that the deposition of the two flake scrapes and the elephant fossil are separated by roughly 7,500 yrs. (500,000 yrs./300 x 4.5) if it took roughly 500,000 years to deposit the 300 meters thickness of the Awidon Mesa series; and

3) The formation from which the fossils of the giant mammal and flake tools were retrieved *in-situ* is believed strongly to be of the Awidon Mesa Foundation. The tuffaceous nature of the beds and the presence of quartz and other characteristic minerals in them, match the characteristic and distinctive description of that Formation.

The above findings tend to affirm the belief that the National Museum researchers have been trying to prove since 1971 that man (tool maker, probably *Homo erectus*) and Pleistocene mammals existed in the Philippines

* Readers who are interested to see the recovered elephant bones together with the two flake scrapers may visit the National Museum, Prehistory section, exhibit at the third floor of the Old Congress Bldg.



STRATIGRAPHIC RELATION OF ESPINOSA RANCH LOCATION I & IV AS SHOWN IN COLUMNAR SECTION.

---Sandstone: grayish orange 10YR 7/4 moderately sorted fine grained, moderately sorted feldspars, hornblende 100% and quartz 5%. The middle of the unit is poorly sorted and counts as rounded granules to pebbles. Basal contact is sharp, bedding is indistinct, poorly indulated to friable. Forms outcrop 11.5 meters thick. This unit contains green claystone at the top which is covered and difficult to expose. Fossil wood on the surface.

---Claystone: dark yellowish brown 10YR 4/2; contains some fine sand size feldspar quartz and hornblende, basal contact, distinct, massive, poorly indurated forms slope 0.5 meters thick.

---Argillaceous sandstone: pale yellowish orange 10YR 8/6, fine grained, moderately sorted, feldspar rock fragments and 5% quartz held together in a clay matrix, basal contact gradational over several cms. Poorly indurated forms slope 2m. thick.

Conglomerate: polymictic, pale yellowish orange 10YR 8/6 to grayish brown 5YR 3/2 poorly sorted, argillaceous sand matrix with equant rounded basalt and andesite granules to pebbles. Some parts are very argillaceous, almost all clay with pebbles; basal contact sharp, massive, moderately indurated .4 m.

Claystone: light, olive gray 5Y 5/2, basal contact sharp, massive, poorly indurated, forms slope 1.6 m. thick.

Siltstone: very pale orange 10YR 8/2 sandy coarse silt that is highly weathered, easily powdered, basal contact, indistinct, graditional over sev. cms., massive, poorly indurated, form slope 1.6 m. thick.

Sandstone: very pale orange 10YR 8/2 well sorted fine grained sub angular sand composed primarily of feldspar and rock fragments, 5% heavy minerals. Grains have a pithy white powder coating. Other beds are x-bedded, indistinctly preserved, poorly indurated, forms outcrop 4.5 m. thick.

FIG. 4

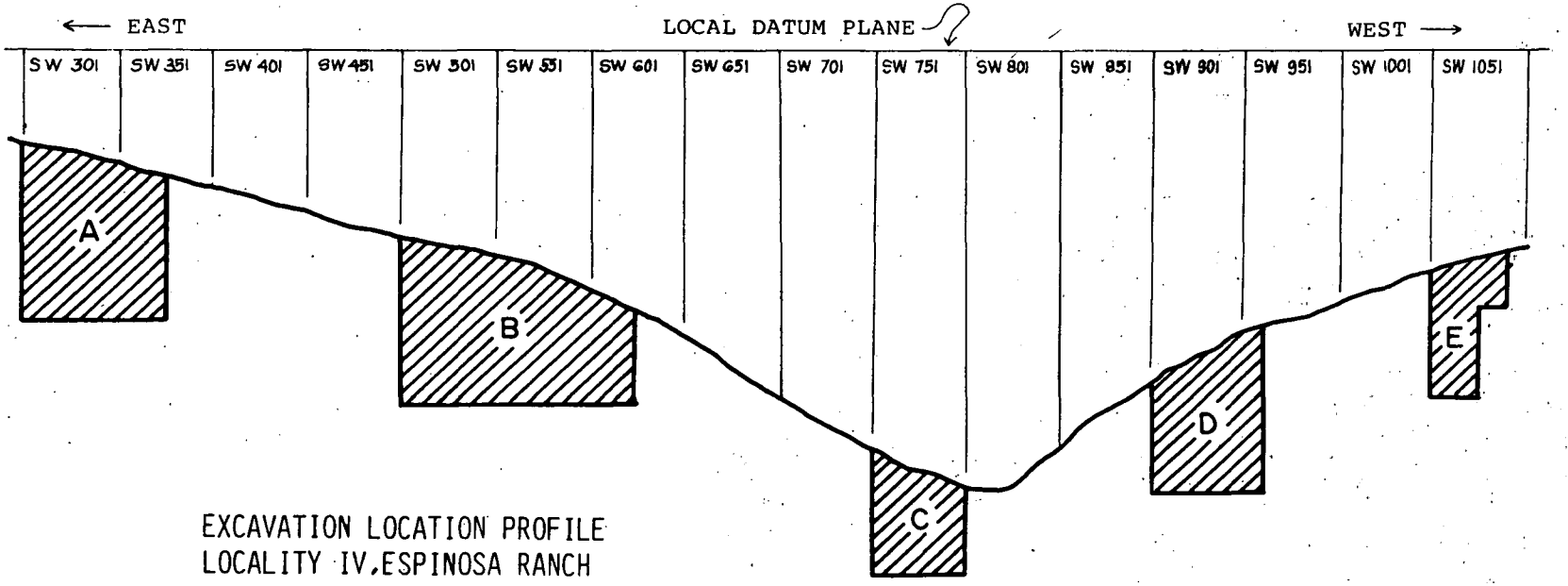

← EAST
LOCAL DATUM PLANE
WEST →
SW 301
SW 351
SW 401
SW 451
SW 501
SW 551
SW 601
SW 651
SW 701
SW 751
SW 801
SW 851
SW 901
SW 951
SW 1001
SW 1051
A
B
C
D
E
EXCAVATION LOCATION PROFILE
LOCALITY IV, ESPINOSA RANCH
KALINGA- APAYAO
SCALE: 1:125
LEGEND:
Excavated squares

FIG. 5

STRATIGRAPHIC PROFILE OF SQUARES A & B (SOUTH WALL)
LOCALITY IV, ESPINOSA RANCH
KALINGA - APAYAO

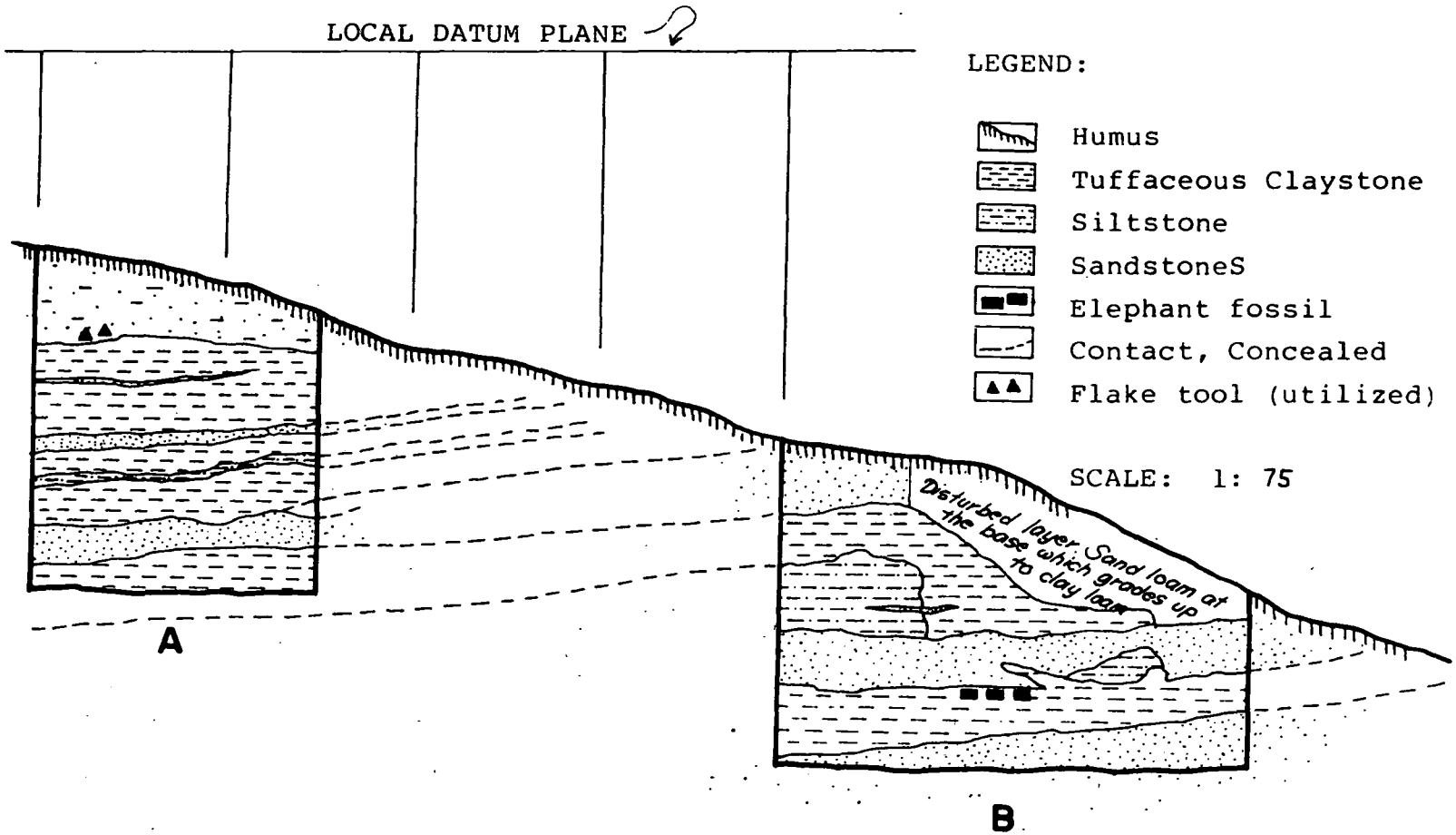


FIG. 6

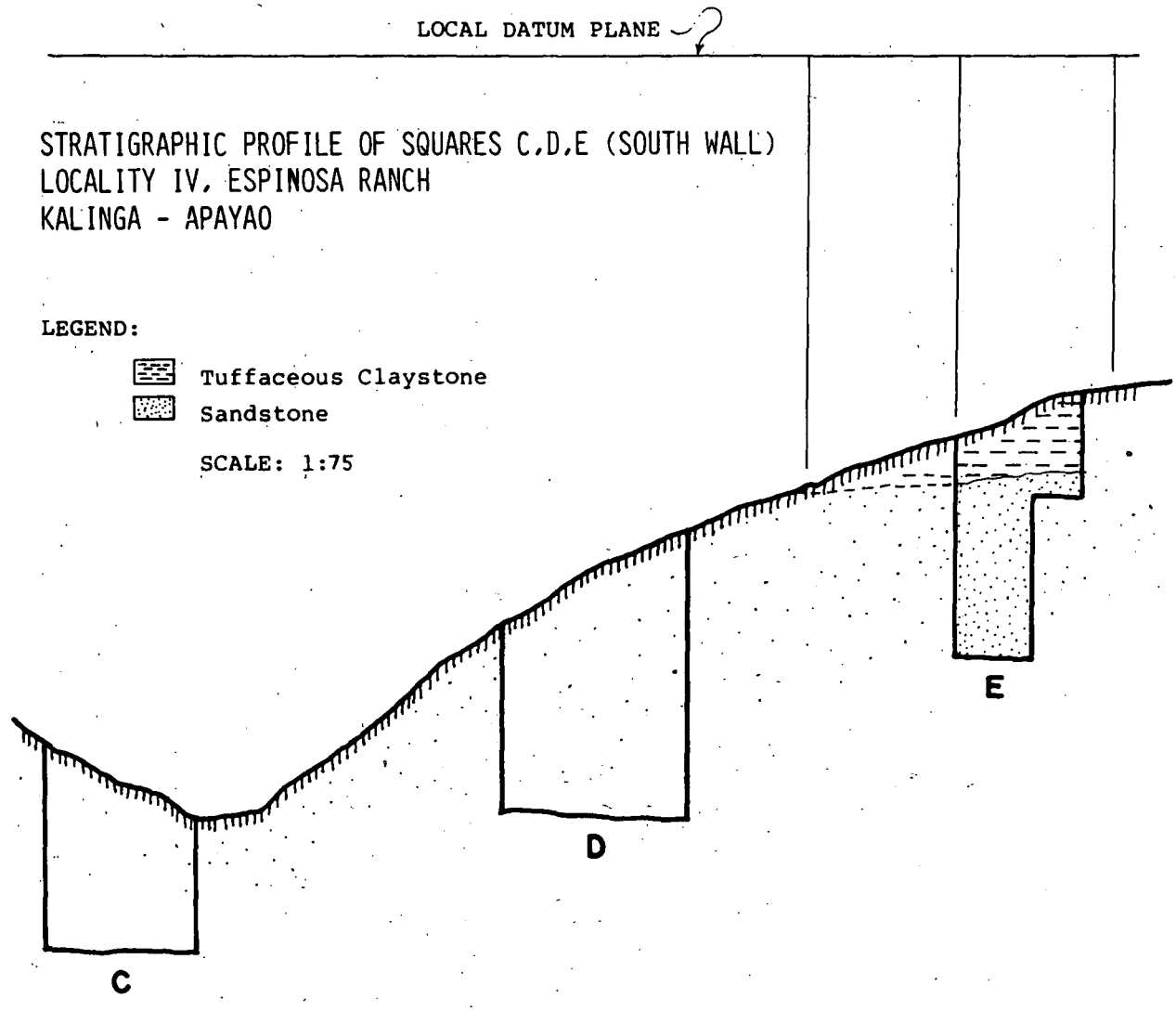
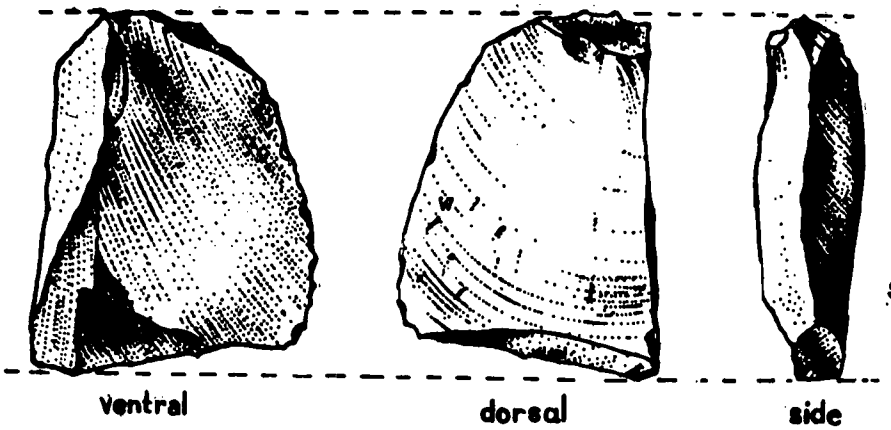
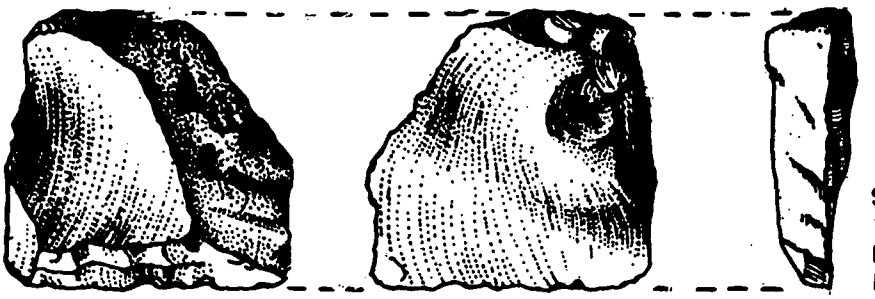

LOCAL DATUM PLANE
STRATIGRAPHIC PROFILE OF SQUARES C,D,E (SOUTH WALL)
LOCALITY IV, ESPINOSA RANCH
KALINGA - APAYAO
LEGEND:
Tuffaceous Claystone
Sandstone
SCALE: 1:75
C
D
E

FIG. 7

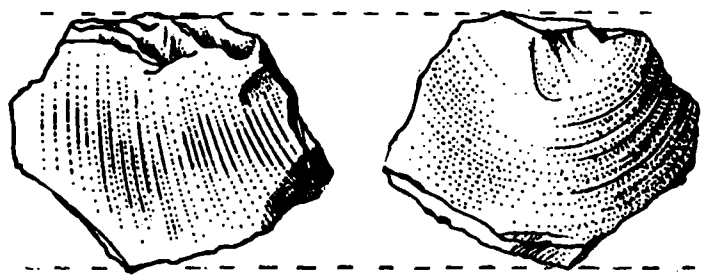


Sq. SW 7 (SW 301)
71-GA-295 (utilized)
NS - 135 EW-62
D 3.13 m. LDP
Actual size



Sq. SW 7 (SW 301)
71-G4-296 (utilized)
NS-132 EW-93
D 3.13m. LDP
Actual size

18



WASTE FLAKE (Actual size)

Sq. NE 967
71-G1 -222
N-S -25
E-W -29
D 519 m. LDP

particularly in the plains of Cagayan Valley as early as mid-Pleistocene time or during the Ice Age when land bridges, now submerged, connected Luzon with mainland Asia allowing their inter-migration.

Acknowledgement

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Definition of Terms Used in this Report

Axis of Anticline – The plane or surface that divides an anticline as symmetrically as possible.

Anticline – A fold that is convex upward or had such an attitude at some stage of development. Anticlines may also be defined as folds with older rocks toward the center of curvature, providing the structural history has not been unusually complex.

Andesite – A volcanic rock composed essentially of andesine and one or more mafic constituent.

Argillaceous – Rocks or substances composed of clay minerals, or having a notable proportion of clay in their composition.

Basalt – A volcanic rock (extrusive rock) composed primarily of calcic plagroclase and pyroxene more generally, any fine grained, dark-colored igneous rock.

Consequent stream – One which follows a course that is a direct consequence of the original slope of the surface on which it developed.

Dacite – A volcanic rock whose principal minerals are plagroclase, quartz, pyroxene or hornblende or both.

Flank – Limb or side of a fold.

Fluvial – Pertains to rivers or anything produced by river action, as a fluvial plain.

Formation – The primary unit of formal mapping or description. Most formations possess certain distinctive or combination of distinctive lithic features.

In situ – In its natural position or place. Said specifically of a rock, soil, or fossil when in the situation in which it was originally formed or deposited.

Knoll – Small rounded hill.

Miocene – The fourth of the five epochs into which the Tertiary Period is divided or the series of strata deposited during this epoch (16-36M.y. B.P.)

Metasediments – Partly metamorphosed sedimentary rocks.

Oligocene – The third of the epochs into which the tertiary Period is at present ordinarily divided. (36 – 46 M.y. B.P.)

Pleistocene – The earliest of the two epochs comprising the Quaternary Period. Also the Past Pliocene glacial age, which the above terminology implies that the glacial age is over. Also the series of sediments deposited during this epoch. Some geologists use Quaternary and Pleistocene synonymously, implying that the glacial age is still with us. (duration: up to 1 million yrs. B.C.)

Slope Wash – Soil or rock material that is being or has been moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels.

Tuff – A rock formed of compacted volcanic fragments especially ash and fine sediments.

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