Morphological Links between distinct cave systems?

An investigation of the magnetic properties of sediments at Matienzo.

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MORPHOLOGICAL LINKS BETWEEN DISTINCT CAVE SYSTEMS? AN INVESTIGATION OF THE MAGNETIC PROPERTIES OF SEDIMENTS.

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ABSTRACT:

Abundant quantities of allogenic clastic sediments are often preserved within cave systems. These sediments can retain, within their magnetic record, details of their depositional and other palaeo-environments.

The evolution of a karstic landscape can dissect and isolate once whole cave systems. The sediment record retained in the isolated caves would however be indicative of the of the original system.

The two observations above form the basis of this study. The sediments from physically distinct cave systems are compared to provide evidence of past connections.

Sediment cores were collected from nine sites in the Matienzo region of northern Spain. The magnetic susceptibility profiles of the cores were measured, in the laboratory at Lancaster, and then compared. From these measurements four groups of caves are identified according to the range of the susceptibility values from their sediments.

A design and construction method for a core sampler to be used in conjunction with magnetic measurements of sediments is discussed within this report.

CONTENTS

CHAPTER ONE:

INTRODUCTION

Caves act as effective repositories for clastic sediments. This sediment record can hold significant palaeoenvironmental information. This study aims to utilise such information in order to further understand the development of a karst landscape.

The development of a karst terrain is dependent on two main criteria:

(1) The presence of a rock that is highly soluble and with well developed secondary porosity.

(2) The presence of a solvent to exploit the properties of criteria (1).

In addition to these two criteria the best potential karst rocks have low primary porosity thus enabling the concentration of solvents into the fissures and cracks causing the secondary porosity. If cave features are to develop and be maintained a high mechanical rock strength is also desirable. The most common karst rocks are limestones followed by other carbonate rocks, evaporites, silica cemented quartzites and siliceous sandstones.

Precipitation within the hydrological cycle forms the basis of the solvents that chemically denude karst rocks. Pure water is relatively ineffective in dissolving carbonates, however, once it is combined with carbon dioxide or organic acids stored in the biomass it can become a potent chemical agent.

Present day distinct cave systems may have been connected in the past. The evolution of the surface karst may have bisected cave passages and isolated sections of cave systems from each other. If the evolution of the landscape progresses in a purely karstic manner, with the absence of erosional processes such as glaciation, it should be possible to link the development of surface and subterranean features. A first step in this procedure is to establish morphological links between now isolated caves. A comparison of sediment stratigraphies from sample cave sites could establish such past links. If the same underground river is the morphogenic agent for development of the two caves similar sediment stratigraphies should be present in both sites.

The area chosen for this study is the Matienzo region of Cantabria, northern Spain. Matienzo presents a well developed karst landscape with an estimated minimum of 1.8 million years of uninterrupted karstic development (Waltham 1981). One significant karst feature of the area is the numerous and extensive cave systems found there.

In pursuit of the aim, to compare sediment stratigraphies, sample sites were identified and sediment cores collected. These cores were later analysed to give magnetic susceptibility values and results between sites compared. Attempts were also made to identify potential palaeocatchments for the rivers acting to form the caves of Matienzo.

The magnetic susceptibility properties of sediment cores were chosen for analysis due to their ability to highlight changes in conditions within the source area of sediments. Alterations in catchment characteristics will be reflected in the corresponding sediments deposited within the fluvial system. Dearing, Elner and Happey-Wood (1981), working in the Welsh uplands, linked high magnetic susceptibility values in lake sediment cores with periods of bank erosion within the lake-catchment. These findings are further explained by Dearing, Morton, Price and Foster (1985) who by utilising magnetic susceptibility values demonstrated the ferrimagnetic mineral depletion down soil profiles. It follows that sediments derived from material with high ferrimagnetic mineral content, such as top soil, can be detected in the depositional zone by magnetic susceptibility measurement.

The importance of understanding karst landscapes and karst processes can be highlighted by a few general statistics concerning the major group of karst rocks, the carbonates. An estimated 12% of the landmasses of the Earth have carbonate rock outcrops. 25% of the world's population benefits from domestic water obtained from them. Considerable mineral wealth is generated from carbonates, 50% of the known petroleum and natural gas reserves plus zinc, silver, lead and bauxite deposits. Carbonates are desirable as building materials providing blocks, aggregate and the cement to bind them together. Finally the often unique landforms generated in karst regions can be of tremendous recreational value reflected in the number of visitors to karst regions.

CHAPTER TWO

AN OVERVIEW OF CAVE DEPOSITS AND THEIR INVESTIGATION.

2:1 INTRODUCTION.

The study of cave deposits has been the main focus for a considerable number of research projects, perhaps more than any other branch of speleological science. Ford and Williams(1989) point to the archaeological and palaeoenvironmental significance of cave sediments to explain this point. Bull(1977) highlights the isolation of cave sediments, within a cave environment, in his assessment of their usefulness in determining palaeoclimatic conditions. The relatively stable cave environment protects sediments from normal weathering processes.

2:2 CAVE DEPOSITS.

Cave deposits can be divided into those found at cave entrances or rock shelters and those found within the interior of caves. Material can be either autogenic, being derived within a cave environment, or allogenic, having a source outside the cave. Interior cave deposits can be further classified according to figure 2.1.

In reconstructing palaeoenvironmental conditions, allogenic and in particular fluvio-clastic sediments are of greatest importance. A notable exception to this is the application of uranium-series disequilibrium dating techniques to calcite precipitates found within caves. Since speleothems can only form in air, minimum ages of cave passages with a phreatic origin can be deduced, when a flooded cave is drained speleothems are able to develop.

figure 2.1 CLASSIFICATION OF CAVE INTERIOR DEPOSITS.

ALLOGENIC	AUTOGENIC
CLASTIC	CLASTIC
Fluvial	Breakdown
Filtrates	Fluvial
Lacustrine	Weathering earths
Marine	
Eolian	
Glacial and fluvioglacial injecta	PRECIPITATES AND EVAPORITES
Dejecta, colluvium and mudflows	Ice
Tephric	Calcite
ORGANIC	Other carbonates
Waterborne	Halites
Exterior fauna	over 180 other minerals

(Source:- adapted from Ford and Williams (1989))

2:3 PRECIPITATES AND URANIUM-SERIES DATING TECHNIQUES.

U-series dating utilises the radioactive decay of two natural uranium parent isotopes ^{238}U and ^{235}U and the subsequent half-lives of their daughter elements, ^{234}U and ^{230}Th for ^{238}U and ^{231}Pa for ^{235}U. The parent uranium is dissolved as part of a carbonate complex in the dissolution of the host karst rock by weak carbonic acid in the form of ground water. The carbonate complex containing uranium is then precipitated in the interior of caves, mainly in the form of calcite and is manifest as one of a host of precipitate formations that adorn the interior of caves. The changing ratio of parent to daughter isotope can then be used to determine the age of such formations. Two main methods are utilised, daughter excess and daughter deficiency, a fuller description of these techniques is given by (Ford & Schwarcz (1990)).

2:4 MAGNETIC PROPERTIES OF SEDIMENTS.

2:4(a) DEPOSITIONAL REMNANT MAGNETISM.

The magnetic properties of sediments are also useful in the dating and comparison of deposits. The depositional remnant magnetism within sediment samples can be interpreted to provide a dating method. Here fine sediment particles, upon settling, preferentially orientate themselves according to the Earth's magnetic field. The variations in the Earth's magnetic field are reflected in the alignment of the sediment particles found through a sediment profile. Over a time scale of millions of years complete polarity switches of the Earth's magnetic field occur. These switches can be read from the palaeomagnetic record. Some authors, however, cast doubt as to the validity of some claims of deciphering palaeomagnetic records using this phenomenon. These issues are discussed in the succeeding section.

2:4(b) REMNANT MAGNETISM, PROBLEMS OF INTERPRETATION.

Watkins(1971) shows how potentially flawed early work in this field is often cited to prove later unexpected findings. This problem is highlighted in the so called "red bed controversy". The magnitude of remnant magnetism contained within red sediments and the abundance of these sediments throughout the world led to many early palaeomagnetic studies being undertaken. The essence of the argument concerns the source of the remnant magnetism that is being measured. Was it acquired at the time of deposition 'depositional remnant magnetism' or was it acquired after deposition due to a chemical reaction that proceeds at an unknown rate 'secondary chemical remnant magnetism'? Compounding the issue are the fine-grained hematite crystals which are responsible for the red colour and the secondary chemical remnant magnetism within red beds. Their small size leads to an instability of their magnetization over a geological time scale. Butler (1992) provides an interesting overview of this debate.

Chronologies described using secular variations within the major periods of polarity reversals have been rather better received. The pioneering work of Mackereth(1971) described a chronology of secular magnetic variations calibrated against radiocarbon dating techniques for a sediment core from Lake Windermere. Oldfield and Richardson (1990) cite observatory records, archaeomagnetic records, models of geomagnetic field changes, pollen analysis and comparison with other secular variation chronologies amongst a host of collaborative tools used for secular magnetic variation studies.

2:4(c) MAGNETIC SUSCEPTIBILITY.

Magnetic susceptibility as defined by the degree to which a sediment core can be magnetised by a fixed, known outside magnetic field can be used to determine the mineralogy of a sediment. The magnetic susceptibility of a material is the ratio of the intensity of magnetisation produced in a sample to the magnetic field that produces that magnetisation. Debate continues as to the units assigned to magnetic properties including susceptibility. Thompson and Oldfield(1986) preferring an SI units based system. Conversely Carmicheal(1989) points to the difficulties of defining basic magnetic quantities and to the historic and conventional use of centimetre, gram and second system (CGS) in literature. It is for these reasons than he makes CGS units his choice. Magnetic susceptibility values can also be used simply as a comparative tool, without determining mineralogy, between various sediment core samples.

Magnetic susceptibility measurements have been extensively utilised in studies of lake sediments. Several examples of this work are quoted in the introductory chapter of this report. Oldfield, Higgitt, Maher and Appleby(1984) point to the extensive occurrence, longevity and ease of measurement of magnetic minerals in stressing the significance of magnetic based studies as a geomorphological tool. The flexibility of magnetic susceptibility techniques coupled with the favourable depositional environment found within caves, see section 2:6, make it an ideal tool for cave sediment studies.

2:5 SEDIMENT GRAIN SIZE.

The calibre of clastic sediments deposited within caves varies from large bedload boulders and gravels down to fine suspended load silts and clays. The presence of fine grained clays is often much in evidence due to the preferential weathering products of the source karst rocks being of that calibre.

2:6 DEPOSITIONAL ENVIRONMENTS.

In cave passages of phreatic origin and vadose caves that experience periodic flooding suspended sediments are often deposited on all surfaces within a cave, including the roof. Typically however the floor is subject to the greatest deposition rates. Due to the complexity of cave systems, often comprising a maze of passages with changing cross-sections and roughness, deposition rates frequently vary considerably within a single cave.

Repeated flooding can remove any pre-existing deposits from main passages replacing them with deposits contemporary with the flood event. Side passages and sheltered areas of caves can however build up suites of sediments due to the low energy environments that exist there. These sites can provide the most extensive sedimentary record within a cave environment. Cave passages that are abandoned as a through route for cave water can also provide conditions in which good sedimentary records can be found.

2:7 PROBLEMS IN THE INTERPRETATION OF CAVE SEDIMENTS.

Caves located in glaciated areas commonly contain varved clays within their suites of deposits. Reworking of sediments by cryoturbation can also be a significant feature in these areas. Both of these processes add to the complexity of deposit stratigraphies and hence their analysis.

Having highlighted the usefulness and versatility of cave sediment studies care must be taken in their interpretation. Jennings(1985) issues the following caveat "These deposits possess tremendous variety, both lithological and genetically; their inheritance of characteristics acquired outside the cave environment and their liability to especially complex stratigraphy make for difficulties in their study, including their classification." This point is particularly relevant to clastic deposits due to the occurrence of both autogenic and allogenic sediments.

2:8 OTHER PALAEOENVIRONMENTAL INDICATORS AND DATING TECHNIQUES FOR INTERIOR CAVE DEPOSITS.

Radiocarbon dating methods have been successfully applied to date organic material, particularly to material found at cave entrances. ^{14}C originating from soils, along with lighter carbon atoms from the bed-rock, can be incorporated into calcite precipitates as they are formed allowing radiocarbon techniques to be applied to speleothems. This technique is however problematic due to the preferential deposition of ^{14}C, the carbon isotope utilised in radiocarbon dating, over other lighter carbon isotopes. The normal limits to radiocarbon dating techniques are between 38 and 45 ka.

Thermoluminescence and electron spin resonance decay methods can also be utilised in the absolute dating of speleothems. In these dating techniques electrons displaced from the crystal lattice by radiation bombardment, originating from either cosmic sources or radionuclide decay, become lodged in other preferred locations within the crystal lattice. The ratio of accumulated dose to environmental dose rate gives the age of the sample. In the case of thermoluminescence the accumulated dose is determined partly by using the luminescent glow curve produced by heating the sample. With the electron spin resonance method the absorption characteristics of microwaves by these dislodged electrons are used. The determination of environmental dose rate is however a limitation of this method, adjacent samples may have varying response rates. Theoretically samples up to 1 million years old can be dated by these methods.

A summary of the reconstruction and dating techniques discused in this chapter is provided in figure 2.2.

figure 2.2 A CLASSIFICATION OF RECONSTRUCTION AND DATING TECHNIQUES FOR CAVE DEPOSITS.

METHOD	TYPE OF DEPOSIT	DATE RANGE
URANIUM SERIES DATING	PRECIPITATES	1ma(daughter excess) 400ka (daughter deficient)
PALAEOMAGNETIC	CLASTIC	over 350ka
MAGNETIC SUSCEPTIBILITY	CLASTIC	COMPARATIVE
RADIOCARBON DATING	ORGANIC/ PRECIPITATE	45ka
ELECTRON SPIN RESONANCE/ THERMOLUMINESCENCE	PRECIPITATES	1ma

CHAPTER THREE

RESEARCH DESIGN

3:1. Cave sediments have been shown to be an important source of data for scientific investigation. Similarities of the physical properties of sediment cores collected from different locations can be cited as evidence of past links between these sites. Magnetic susceptibility is a particularly applicable property of cave sediments that can be employed for this purpose. The aim of establishing past morphological links between presently isolated cave systems can then be addressed by the comparison of magnetic susceptibility values of sediments samples collected from each cave. Having established the research criteria the task of choosing a study area remained.

3:2. The main criteria used in identifying a study area were as follows:-

(1) The presence of caves containing relatively undisturbed allogenic clastic sediments.

(2) A prior personal knowledge of the caves of the region.

(3) The ease of access to sites with sampling equipment.

(4) The ease of access to the study area within the twin constraints of finance and time.

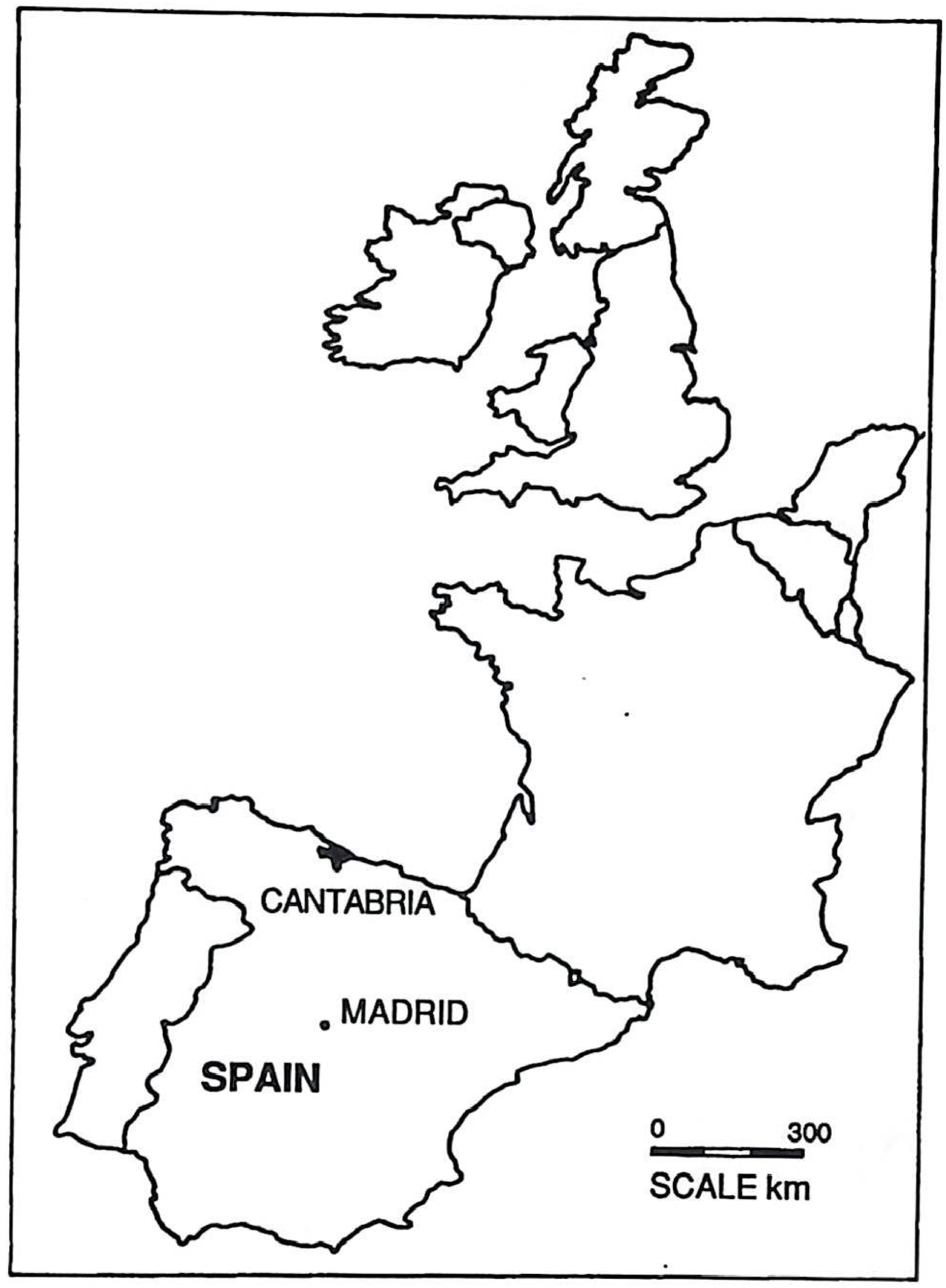
(5) The availability of the assistance necessary in order to enter and collect samples from caves safely.

The Matienzo area of northern Spain (see maps 3:1 and 3:2 for location) fitted all of the above criteria well. The lithology and geological structure of the Matienzo area are discussed in section 3:5. The region is of sufficiently low altitude to have avoided Pleistocene glaciations, see section 3:19. Apparent rapid changes in the level of the phreatic surface, downwards, left relic cave passages with undisturbed interior deposits. Direct ferry routes to northern Spain, from England, or a twelve hour drive through France make the area relatively easy to access. The willingness of the "Matienzo Caving Expedition" to aid in sample collection and the relative ease of the caving found there much aided core collection. Finally the area is well known to myself after successive visits to the area over the past twelve years.

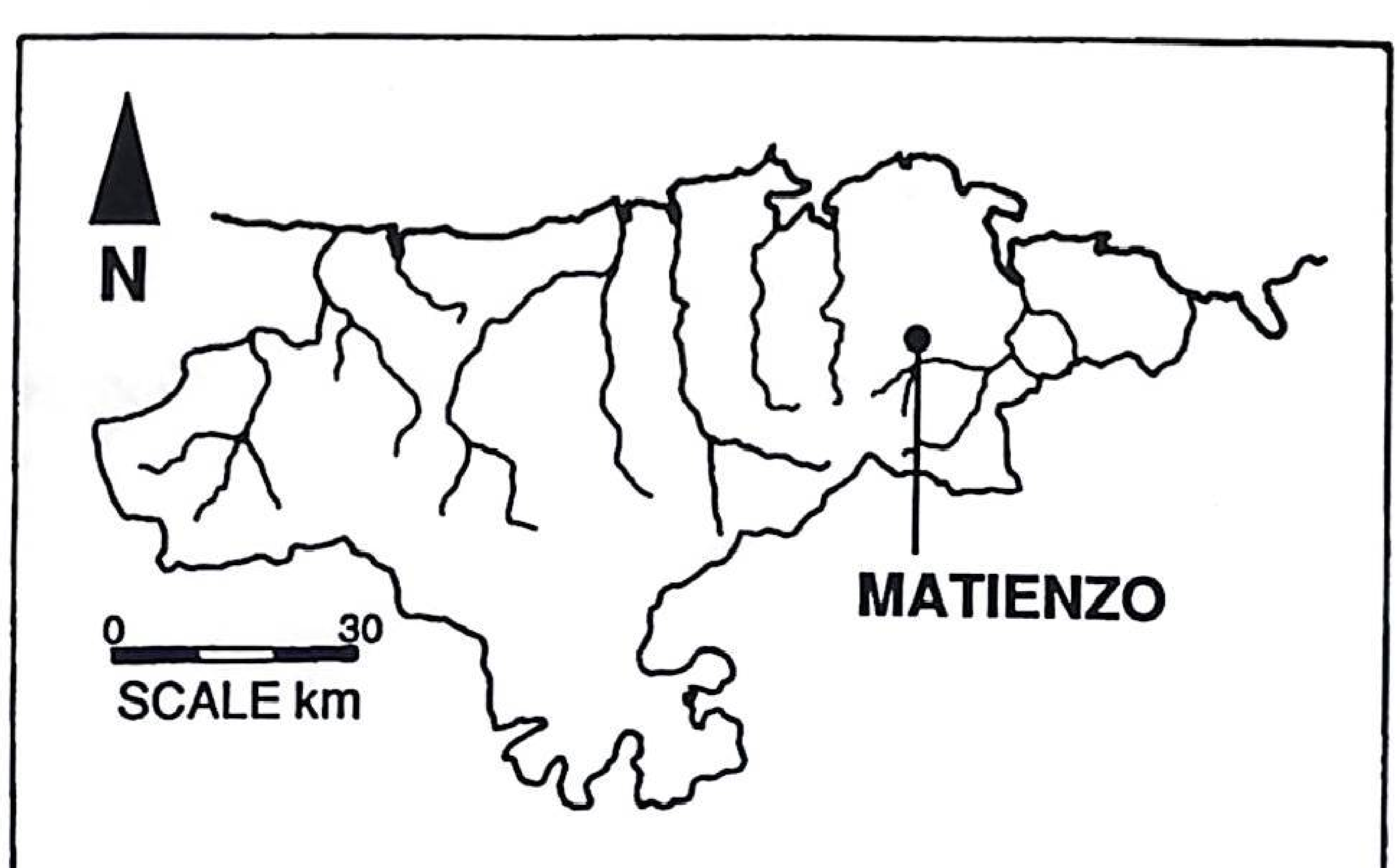
3:3. Other potential study areas known to the author are the Three Peaks district of the Yorkshire Dales and the karst regions of northern Vietnam. Caves in both these regions often contain considerable amounts of clastic deposits. The latter area was soon eliminated due to the considerable logistical problems involved in

MAP 3:1

LOCATION of CANTABRIA

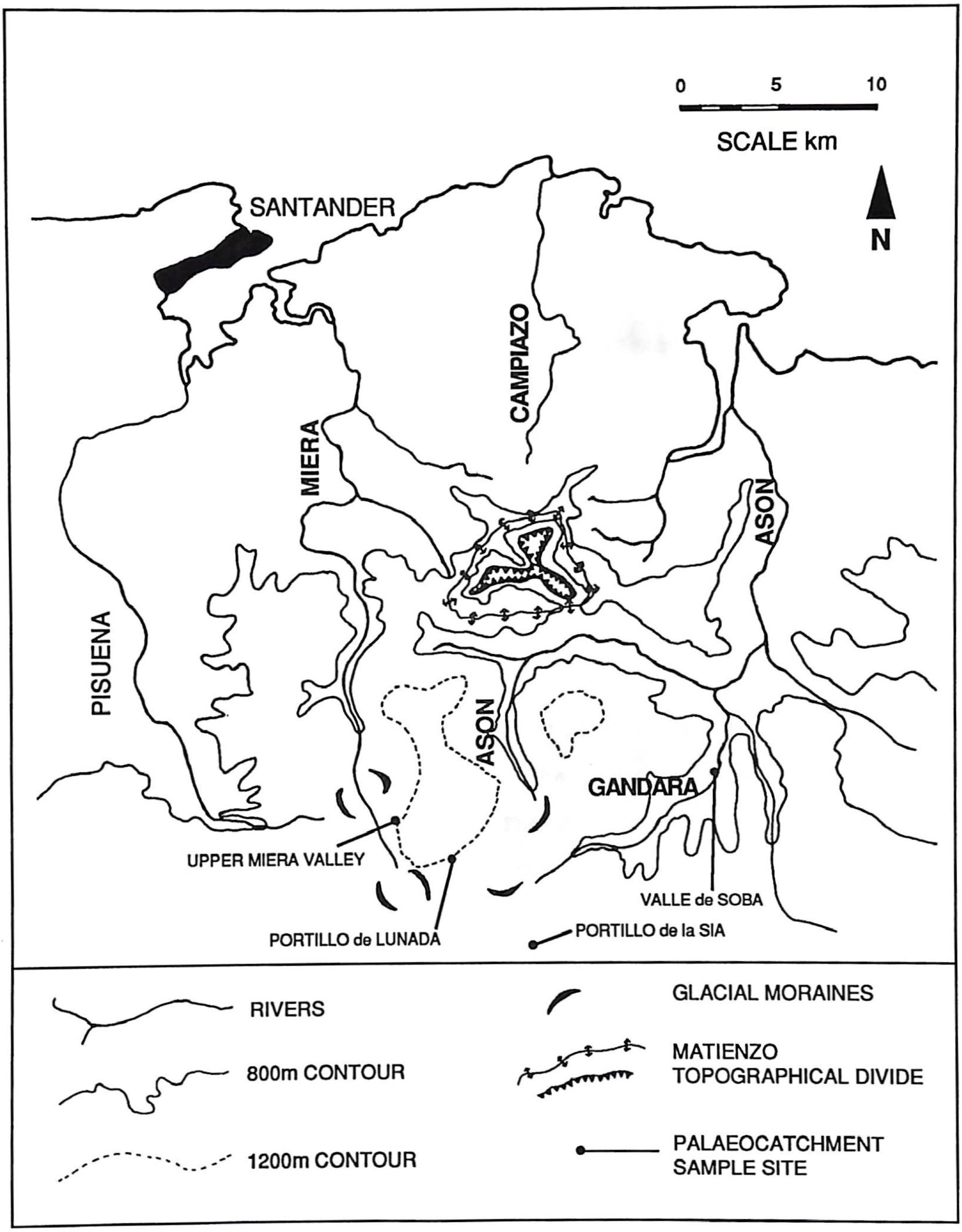


CANTABRIA SHOWING MAIN RIVERS AND LOCATION OF MATIENZO



map 3:2

THE MATIENZO REGION SHOWING PALAEOCATCHMENT SAMPLE SITES



instigating a research programme in South East Asia. The potential complexity of deposits due to glacial action in the Yorkshire Dales and the strong influence of glacial erosion itself on karst evolution found there precluded that option.

3:4. THE MATIENZO CAVES AND KARST.

The main karstic feature of the Matienzo area is the large enclosed depression that bears the name of the region. The area contained within the topographical divide of the depression is 26.3 km^2 of which around 3 km^2 consists of the nearly flat 'Y' shaped valley floor.

The northern arm, La Secada(plate 3:1), contains the hydrological outlet to the valley, Cueva de Carcavueso(altitude 145m). The col leading out of this end of the valley is at an altitude of 450m.

The arm to the south east, Ozano, contains a small tributary stream that joins the main Matienzo river before it enters Cueva de Carcavueso. The col at the head of the Ozano arm, at an altitude of 364m, is the lowest point on the topographical divide of the depression.

La Vega arm(plate 3:2), to the east, contains Cueva del Comellante which is the resurgence cave for the main Matienzo river. The river connects between La Vega and La Secada via a cave, Cueva del Agua. The exit col of this arm is at an altitude of 678m. Alluvium covers the flat areas of all three arms. The axis of a regional anticline roughly follows the line of La Vega arm. This arm of the depression is perhaps the best known in speleological terms. In view of this and the desire to limit the geographical extent of the study La Vega was chosen as the area to be investigated.

3:5. LITHOLOGY AND GEOLOGICAL STRUCTURE OF MATIENZO.

Field observations, information gained from geological maps of the area (Mapa Geologico de Espana 1978) and details given by (Mills and Waltham 1981) were consulted in the preparation of this section. Other than unconsolidated valley floor alluvial deposits the entire area is formed in rocks laid down in the lower Cretaceous period. The large majority of rocks are limestones occasionally containing thin sandstone beds and lenses. The limestones are up to 600m thick and are divided into the 300m thick, thin bedded Albian rocks, the 100m thick massive bedded Urgonian limestone and the 200m thick, thin bedded, Aptian rock. Underlying the limestones and forming a boundary to karstic development are impervious Barremian sandstones and marls. These underlying beds occasionally outcrop in the Vega and Ozano arms of the

PLATE 3:1
VIEW LOOKING NORTH INTO La SECADA ARM OF THE MATIENZO DEPRESSION. TAKEN FROM THE FLOOR OF THE OZANO ARM.

PLATE 3:2
VIEW LOOKING EAST INTO La VEGA ARM OF THE MATIENZO DEPRESSION.

depression. This geological sequence is summarised in figure 3:1.

figure 3:1 GEOLOGICAL SEQUENCE FOR MATIENZO.

AGE	THICKNESS	DESCRIPTION
ALBIAN	300m	Thin bedded limestones, with some massive beds.
APTIAN	100m	Massive bedded Urgonian limestone , with thin marls.
APTIAN	200m	Thin bedded limestones with orbitalinas, also thin sandstones.
BARREMIAN	500m	Sandstones and marls.

(Source:- adapted from Mills and Waltham 1981.)

The folding of rocks in the area is associated with the Alpine orogeny. One result of this activity is a regional anticline with its axis running from west to east through the Matienzo depression. The anticline is evident by the gently dipping limestones, close to 5^{o}, to the north and south of the axis(plate 3:2). It is along the axis of this anticline that the Barremian sandstones occasionally outcrop. Associated synclines can be observed to the north and south of our area. This simple geological structure is complicated by considerable local faulting. The noticeable variations in rock strata dip can be attributed to the often rotational nature of this faulting.

3:6 SEDIMENT SAMPLING

The investigation of possible morphogenic links between the chosen sites necessitated laboratory analysis of sediment cores taken from the caves in question. A suitable sampling device was required for the task. The lack of a commercial sampling tool facilitated the design and construction of such a device before departure for the study area.

3:7. DESIGN AND CONSTRUCTION OF THE SAMPLING DEVICE.

The following criteria were to be considered in the design of the sediment corer.

1) The harsh conditions for the transport of the device and the collected samples.

2) Estimated sediment thickness of up to 2m.

3) Containment of the collected core.

4) Later identification of the core.

5) Possible future analysis of the palaeomagnetic properties of the core.

6) The expense of construction.

7) The probable number of samples to be taken.

8) The requirements of the Bartington magnetic susceptibility meter and sensor to be used for laboratory analysis.

9) The physical properties of the sediments and sediment banks.

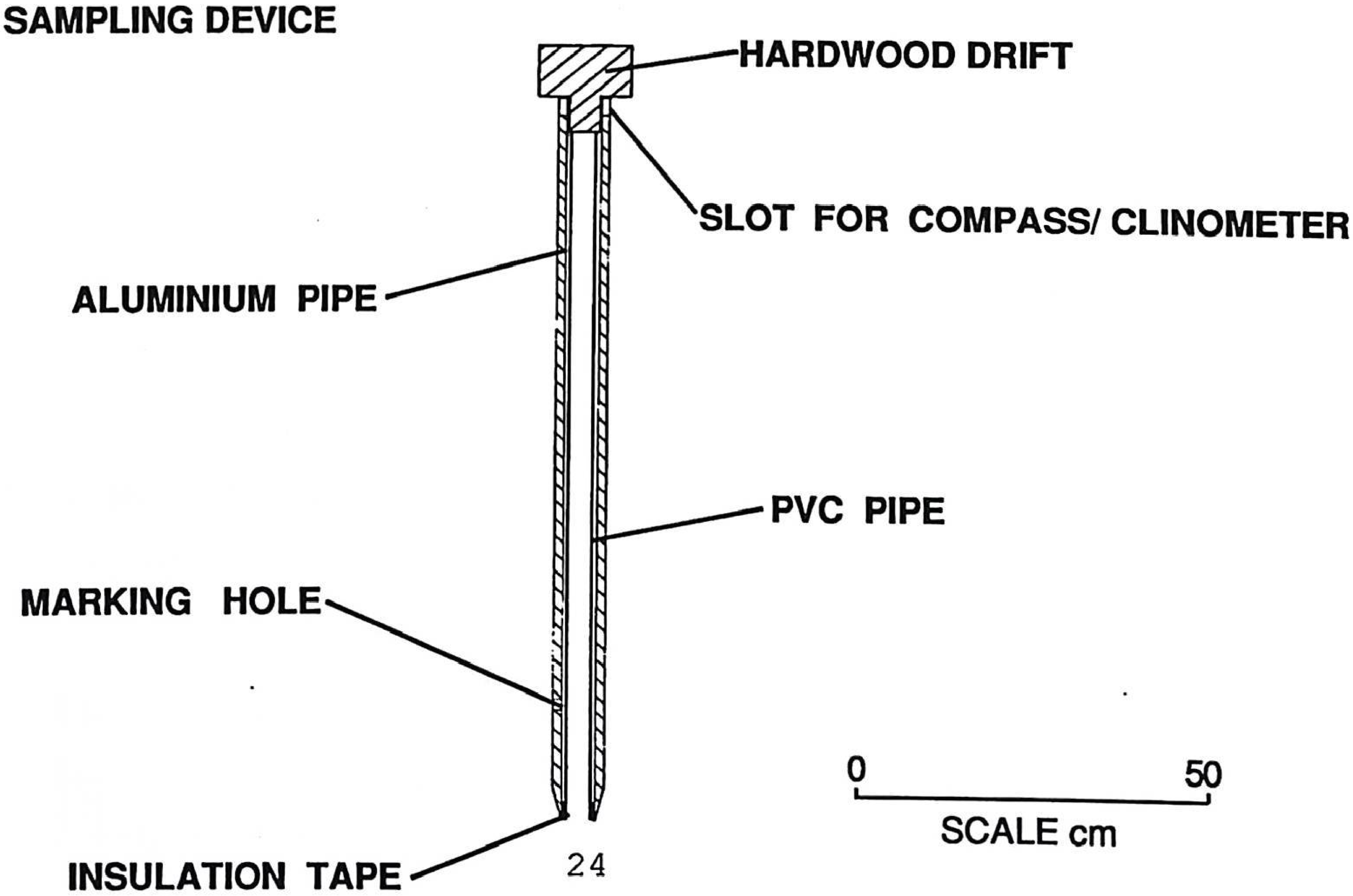
3:8. All the materials used were of a non ferrous material to eliminate potential problems with induced magnetic effects.

A cylindrical aluminium tube 105cm long and of sufficient gauge to withstand repeated insertions into sediment banks was chosen for the body of the device. The bottom edge of the tube was tapered to ease the insertion of the device.

The top of the tube was constructed with slots along the forward facing axis of the cylinder into which a narrow gauge plate of stainless steel could be inserted. This enabled a compass to be temporarily fitted to the sampler to measure the orientation of the sample core. A clinometer could also be used in this manner to measure declination of the sample and to ensure a constant angle of insertion for the tube. Figure 3:2 shows a design drawing for the sampling device.

The collected core was encapsulated within a PVC pipe contained within the body of the aluminium tube. The external diameter (42mm) of the PVC piping was the closest commercially available to the internal diameter of the aluminium tube(42.5mm). The potential problem of sediment being driven between the outer and inner portions of the corer was overcome by extending the outer diameter of the PVC tubing at the base by adding several layers of insulation tape until a snug fit was achieved. The forward facing edge of the PVC tube was marked with an indelible pen through a hole, aligned with the orientation slots on the top of the device, in the outer aluminium. The measurement of orientation, declination and the marking of the leading edge of the PVC sample tube were essential due to possible future analysis of the collected cores for their depositional

FIGURE 3:1. SAMPLING DEVICE



remnant magnetic characteristics. Thirty 1m lengths of PVC tubing for core collection purposes were taken to the study area. This figure was a conscious overestimate of need due to the probable unavailability of replacements in Spain.

3:9. SELECTING SAMPLE SITES.

The caves investigated represent a cross-section of the available sites in La Vega. Sites chosen were from the northern, southern and western sections of the valley. Both present day active caves and relic cave passages were sampled. Several of the caves selected for investigation have development on several levels. In these cases cores were taken from each major level. The South Vega System was a notable exception to this (see appendix 1).

3:10. In determining suitable sediment banks to be sampled similar criteria were used in each cave. Certain sites were rejected including sites with probable autogenic input sources close by. Dejecta cones from holes in cave roofs and areas of passage breakdown are typical sources of such sediments. Sediments disturbed by anthropogenic influences, often unavoidable in the process of cave exploration and surveying. In general fine grained sediment banks with a fluvial form were chosen. The problem of autogenic material undergoing transport, modification and deposition in a fluvial regime, hence becoming combined with allogenic material must however be noted.

3:11. BRIEF DESCRIPTIONS OF SITES AND CAVES.

Surveys of all the sections of caves that were sampled are shown after the site descriptions. Grid referances and lengths of the sample caves are given in figure 3:3.

figure 3.3 DETAILS OF SAMPLE SITES.

(one core was taken at each site).

CAVE NAME	No. OF SITES	GRID REF	ENTRANCE ALTITUDE (m)	CAVE LENGTH (m)
TORCA del COTERON	1	VN5125 9539	370	21475
CUEVA del COMELLANTE	1	VN5079 9575	170	450
CUEVA del ARENAL	1	VN4930 9513	220	200
TORCA REGATON	1	VN5019 9723	303	3247
TORCA del MOSTAJO	3	VN5035 9699	312	6582
CUEVA de COBERRUYO	1	VN5153 9639	300	150
CUEVA de RASCAVIEJA	1	VN5179 9638	300	450

Map 3:3 shows the positions of these cave entrances. Rose diagrams showing passage orientation and 'levels of development' diagrams for each cave are shown in appendix 2.

Torca del Coteron(map 3:4) is the middle entrance (in terms of altitude) to the South Vega System. The combined lengths of the major constituent caves of this system (Torca del Azpilicueta; Torca del Coteron; Cueva de la Renada) make it the longest in the area. The two main passage developments in Coteron are centred around the 230m and 200m altitudes. The character of the cave is almost entirely of a relic phreatic nature containing substantial quantities of sediment. Access to these levels is via two "pitches" of 45m and 13m depth. The sample site in the cave was in the vicinity of "The Edge of the World" found on the 230m level. Two and a half hours caving is required to reach this point.

Cueva del Comellante(map 3:5) is the resurgence for water found in the lower levels of the South Vega System. Water sinking within Cueva de la Renada has been proven, by dye tracing, to emerge within Comellante from where it emerges into La Vega valley. Typical discharges of around 0.5 cumecs have been previously recorded. The short horizontal nature of this cave makes access relatively easy. Normal progress is halted when the cave roof descends to meet the water level (sump). The sample site is 30m before the sump and 5m above that level. The source of this water, beyond the lower levels of the South Vega System, is at present unknown.

Another smaller resurgence is found at the head of La Vega, **Cueva del Arenal(map 3:6)**. The three entrances lie 20m above the valley bottom and permanent spring level. At times of flood however water can be observed emerging from the main cave entrance. The very strong cold draught emerging from the cave suggests that considerable dry extensions to the known extent of this cave exist. The sample site for Arenal is just beyond the entrance zone of the cave.

Torca Regaton(maps 3:7 & 3:8), found on the northern slopes of La Vega, was a new discovery in 1992. The entrance series drops almost entirely vertically for 130m. The largest single drop of nearly 70m necessitates the use of specialist "single rope" techniques and equipment to enter the lower reaches of the cave. Other than the entrance drops of the cave the entire known passage development is at this lower level. The altitude of this development(circa 180m) corresponds to the present day valley floor level. The lower passages can be placed into two categories, active vadose streamways and larger abandoned phreatic tunnels with occasional windows down to the phreatic zone. The sample site is mid way along the main abandoned section of the cave. The discovery of this cave facilitated a rare opportunity to study a feature untouched by human influences. The author was only the third person to enter the cave. Plate 3 shows the sediment bank that was sampled in Regaton. Plate 4 also taken im Regaton illustrates the phreatic passage type found in many Matienzo caves.

Torca del Mostajo(maps 3:7 & 3:8) is an extensive cave on the northern side of La Vega. Two distinctive levels of relic phreatic development are in evidence, figure 3:4 indicates the altitudes of these developments. Entry to the upper level at an altitude of 280m is via an entrance drop of 22m. This large dry tunnel contains many deposits, both clastic and calcite precipitates. A further vertical drop of 30m from the upper gallery accesses the 240m level extensions. Unlike the upper passages development at this level does not follow a linear pattern, the confusing number of passage directions can lead to route finding problems. The complex passage orientation is highlighted in survey of the cave, map 3:8, and the rose diagram of passage orientation, figure 3:4. Deposits are however again abundant and the passages are clearly phreatic in origin. Specialist caving knowledge and equipment are needed to enter this system. Three sample sites were chosen in Mostajo. The first site is found 200m along the upper level. The potential problem of calcite intrusions into the clastic sediments at this site led to the taking of another sample from the upper level. The second sample site was a further 230m along the level. A site 300m from the entrance to the lower extensions was chosen for sampling from the 240m level.

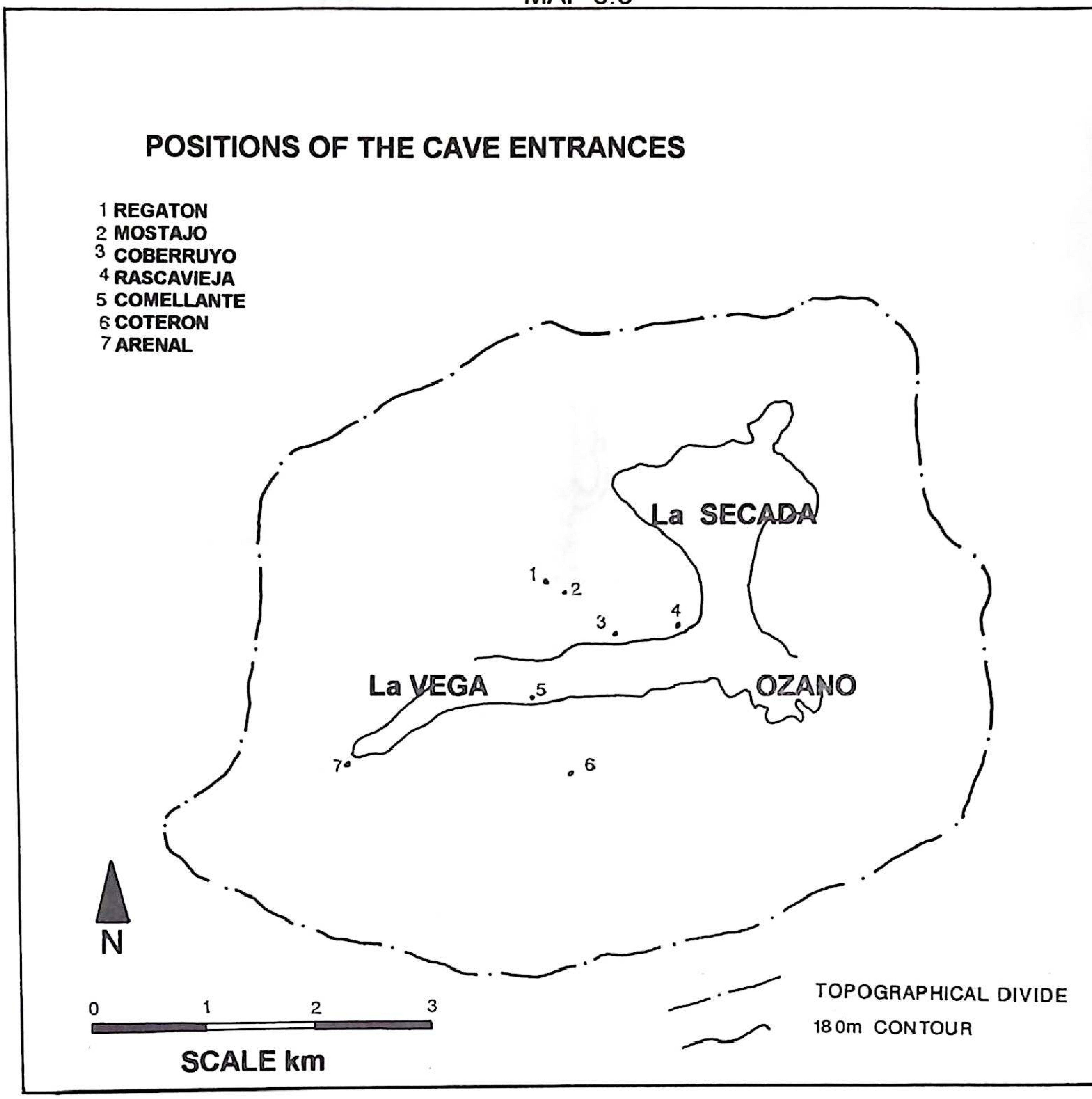
The survey plans and elevations of Regaton and Mostajo(maps 3:7 & 3:8) illustrate the two caves' juxtapositional relationship. Where overlaps do occur however large vertical and horizontal displacements separate the two caves. The close vicinity of the two caves led to the expectation of similar sediments to be present in each.

The final two cave sites have their entrances situated at the base of a high cliff, formed in Urgonian limestone, situated on the northern edge of the valley.

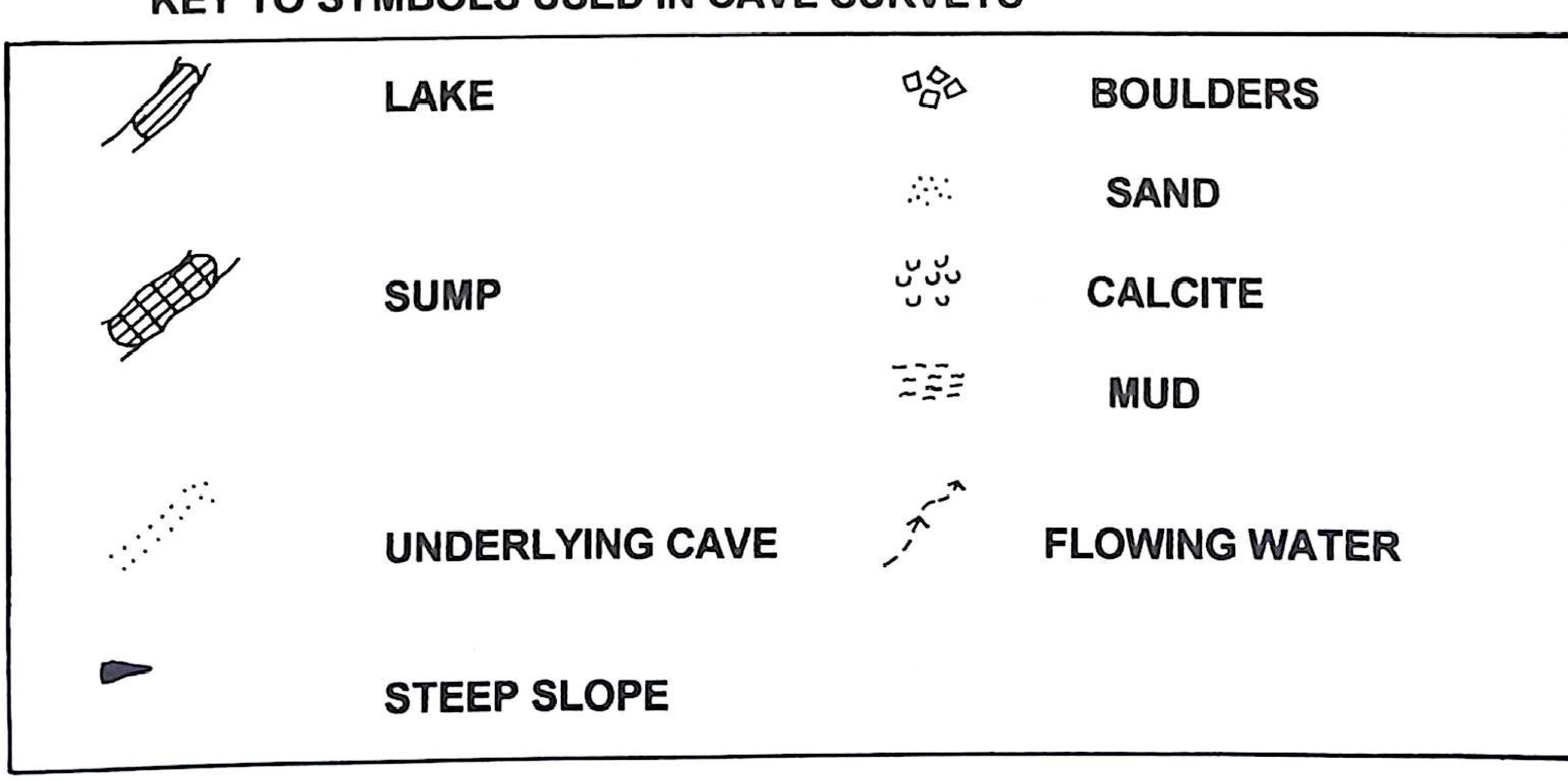
The short **Cueva de Coberruyo(map 3:10)** appears to be a segment of an old fossil phreatic cave running parallel to the edge of the valley. The entrance in the centre of the cave may have formed when the valley developing laterally breached the cave passage. The core site is found 46m along the eastern heading branch of the cave.

A steeply descending slope 50m long leads to a 30m wide passage in **Cueva de Rascavieja(map 3:9)**. The cave passage heads directly into the hillside and is blocked by a large boulder fall. The sample site is situated within an alcove 60m along the eastern wall of the passage, away from the influence of surface debris and autogenic breakdown transmitted down the entrance slope.

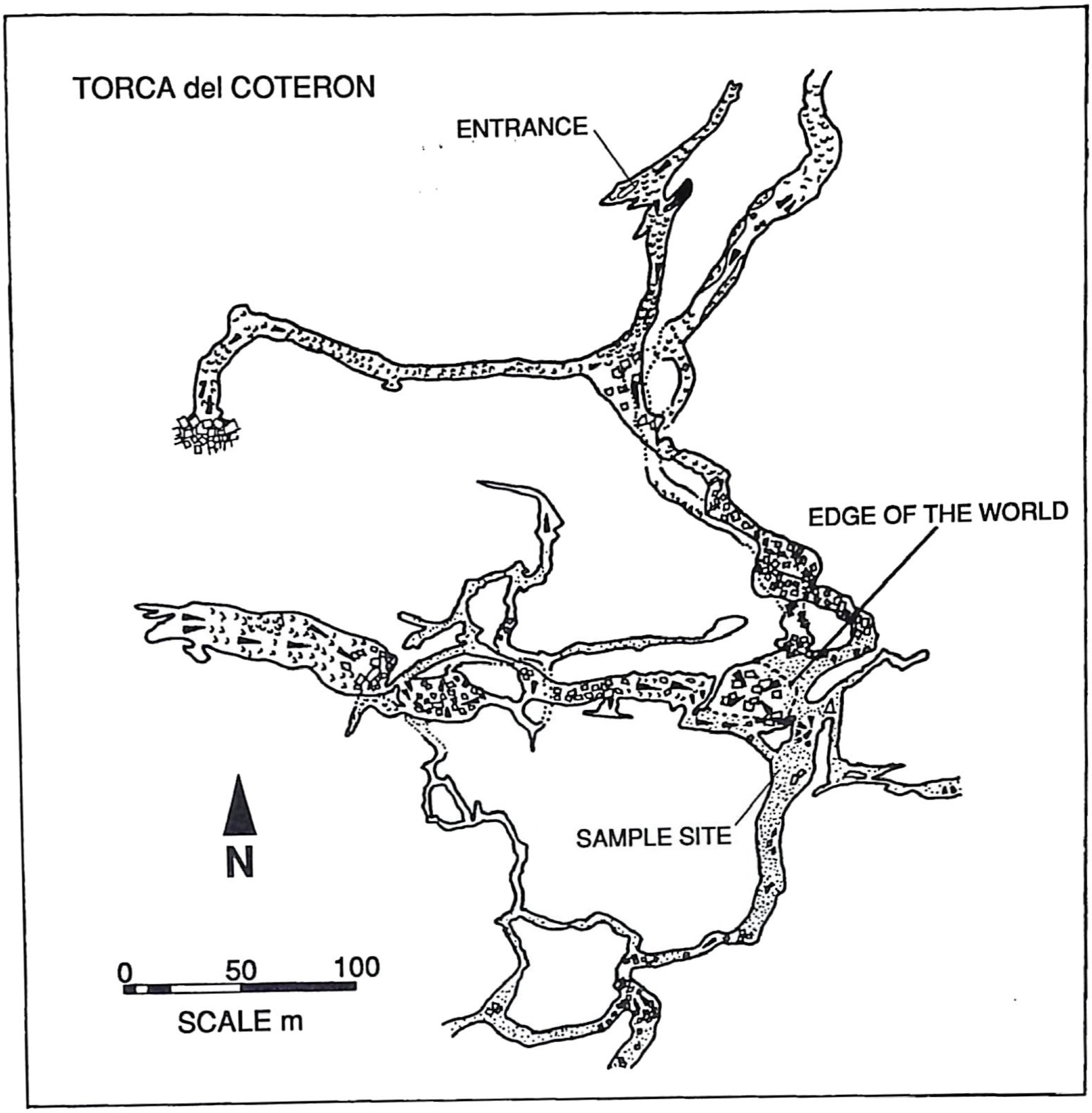
MAP 3:3



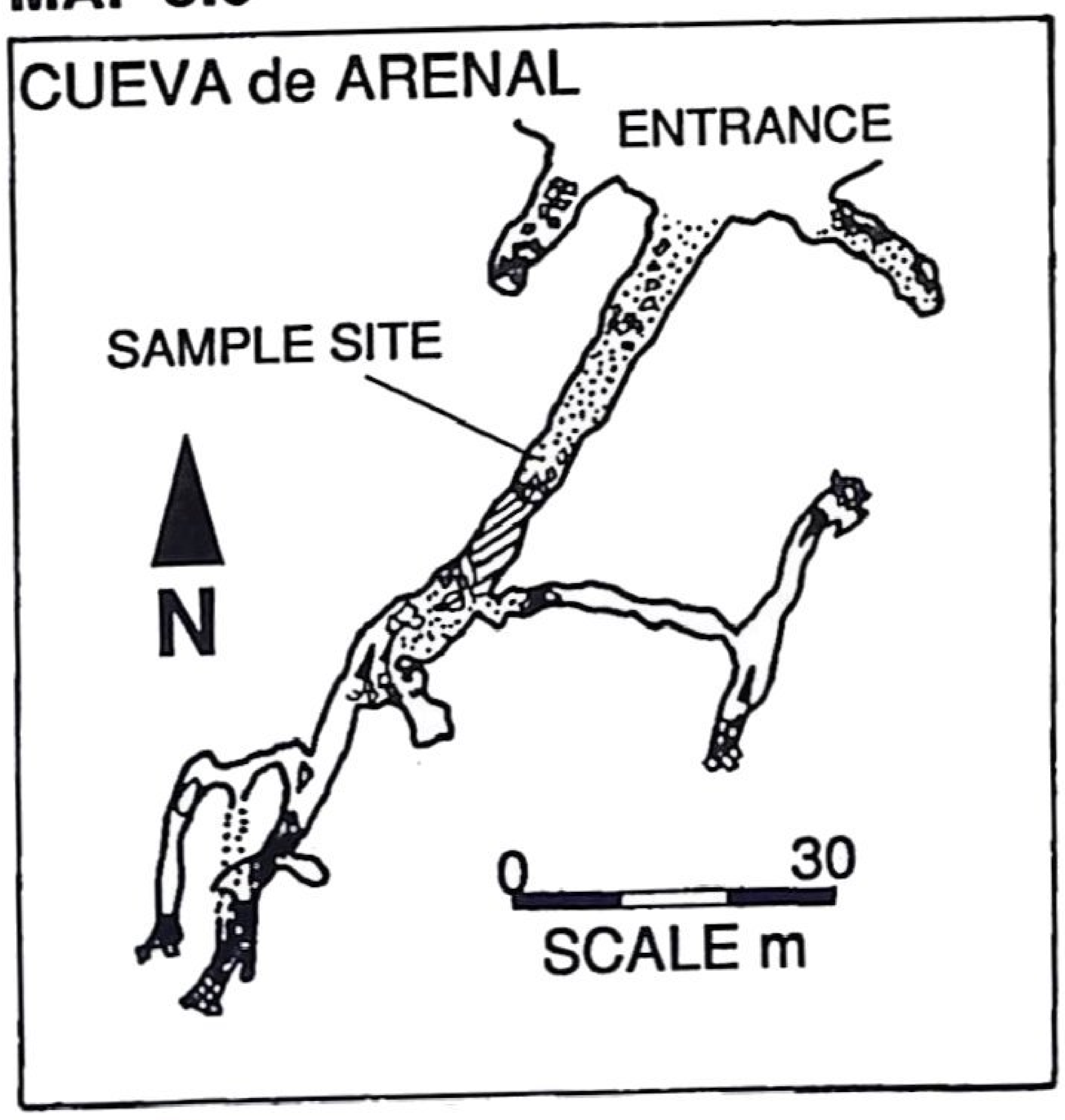
KEY TO SYMBOLS USED IN CAVE SURVEYS



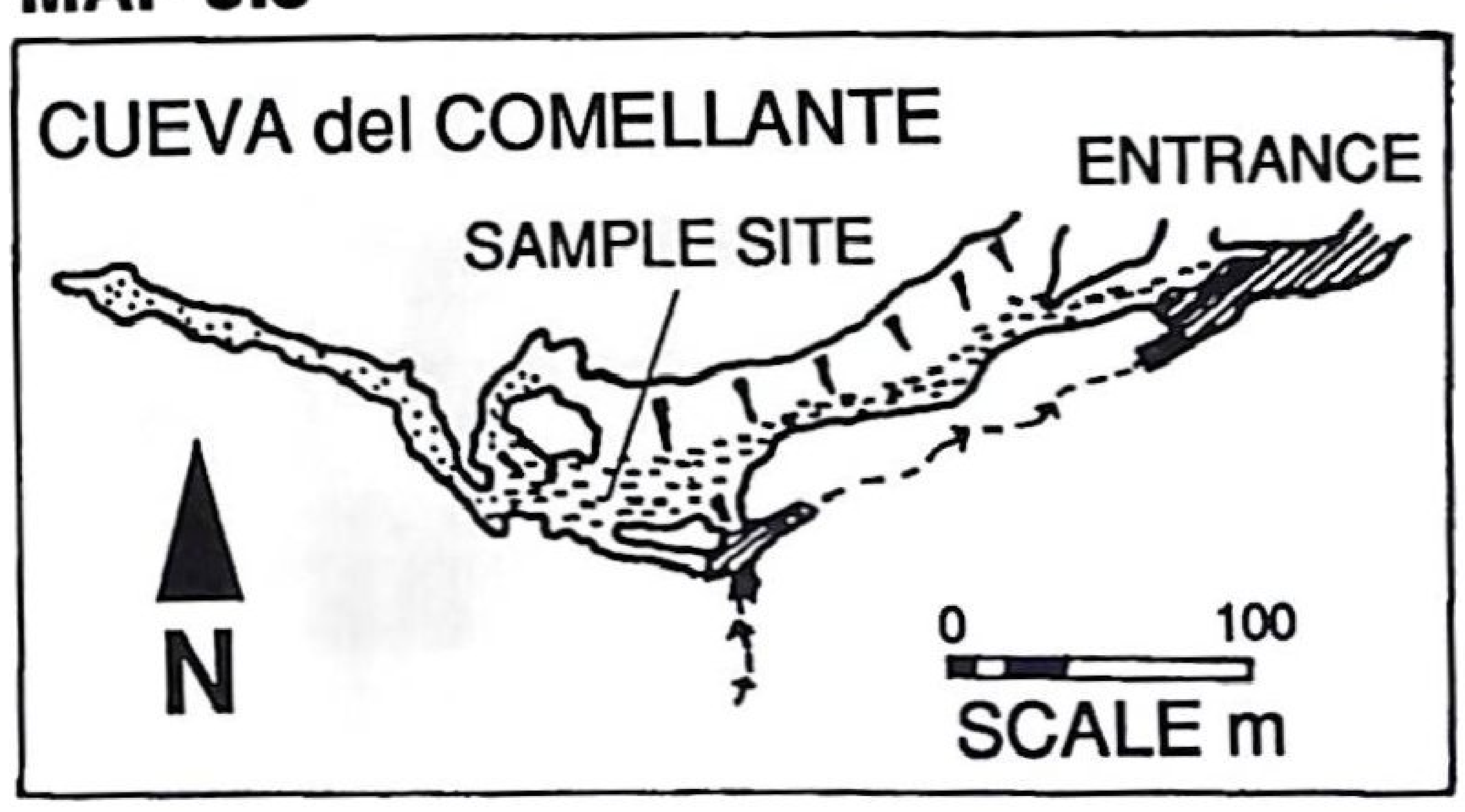
MAP 3:4



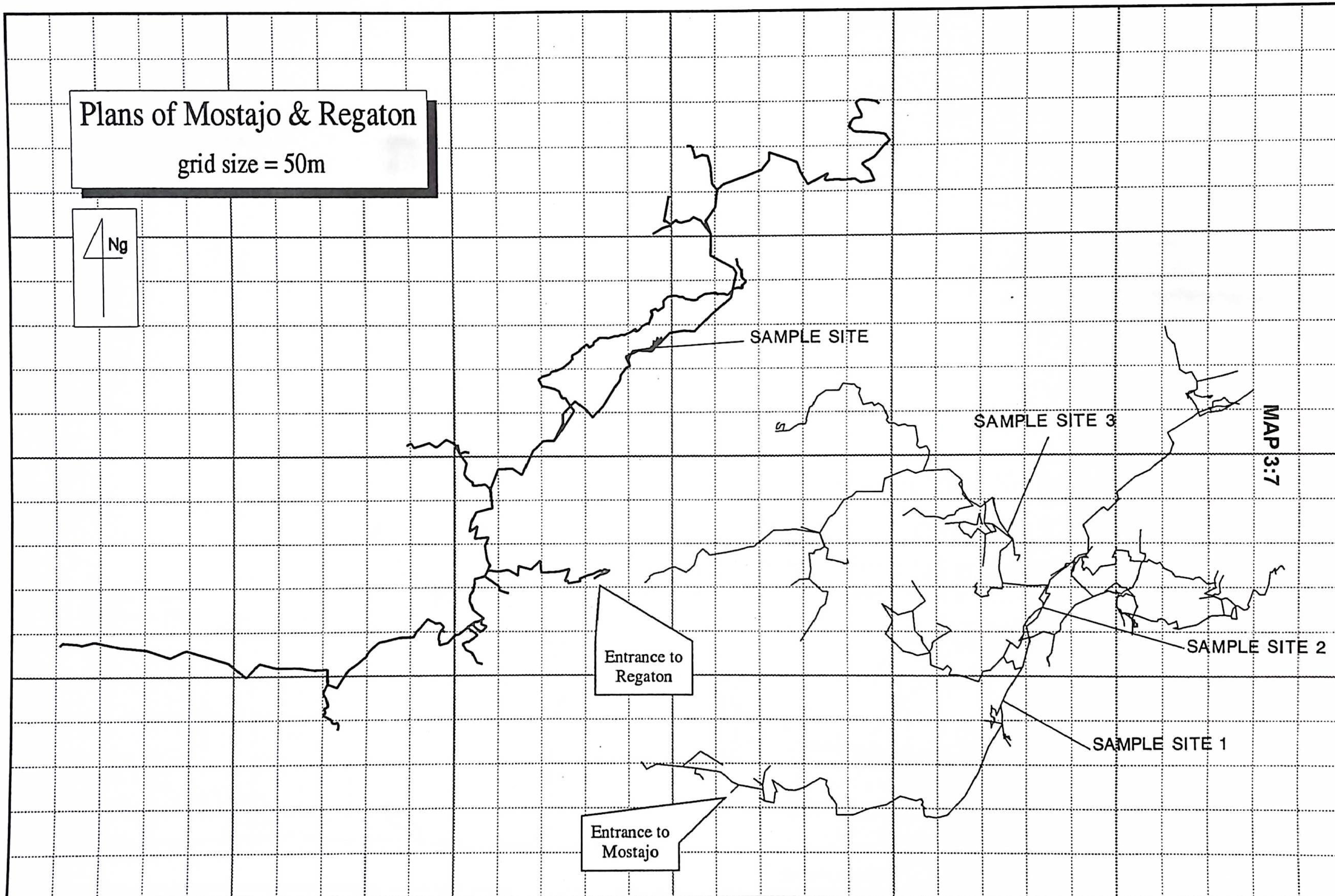
MAP 3:6



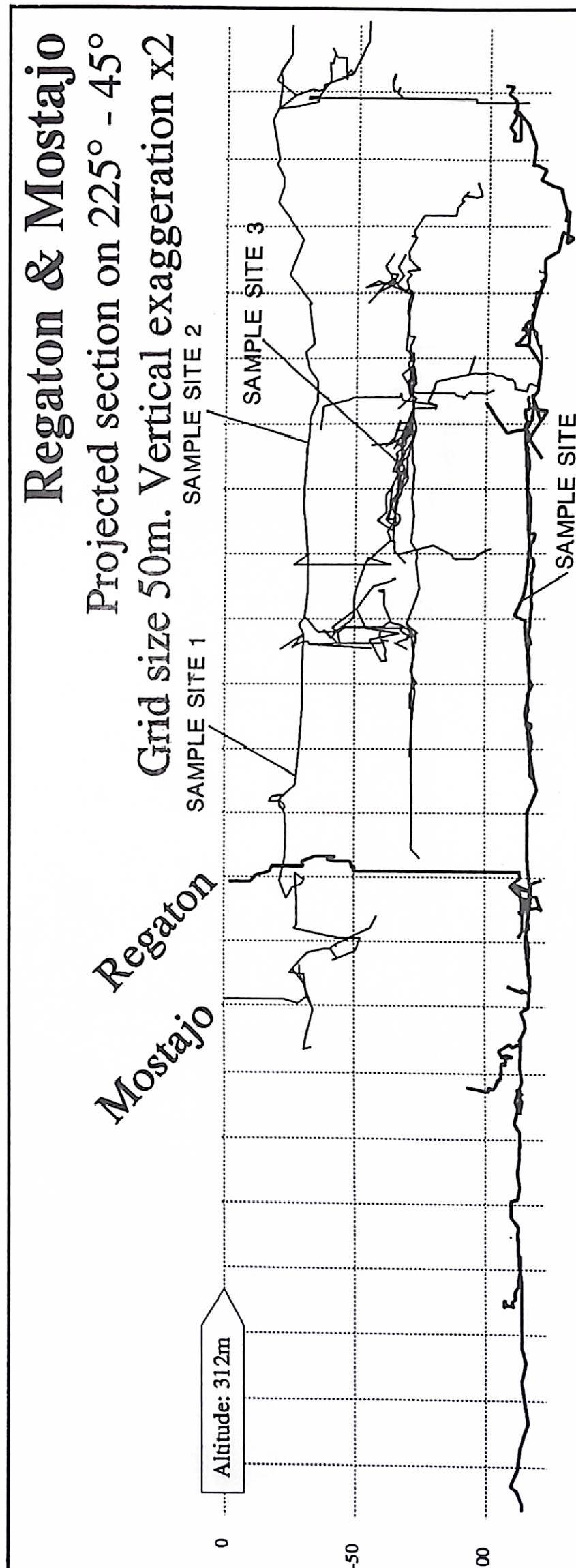
MAP 3:5



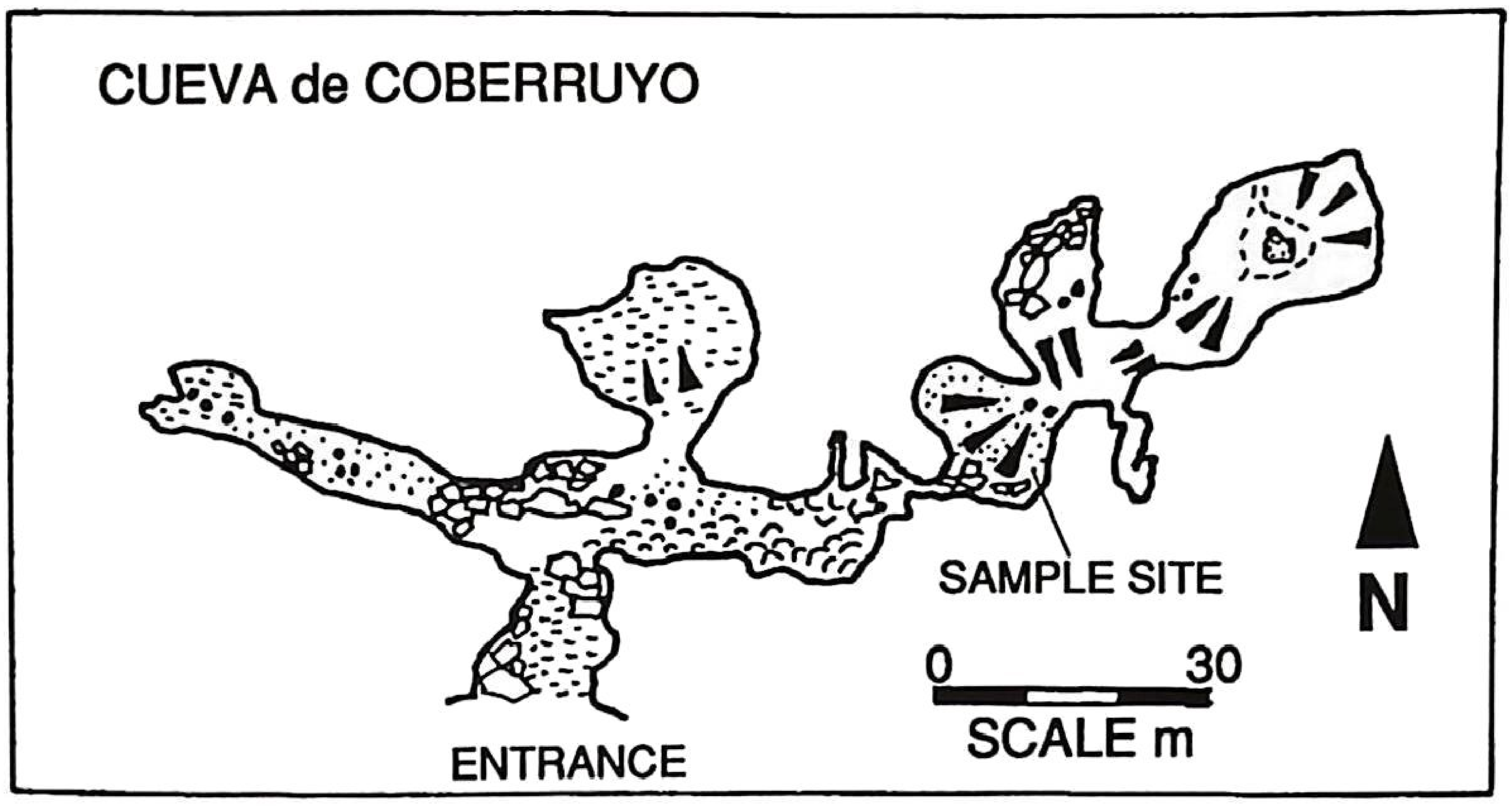
FROM ORIGINALS BY P. SMITH


Plans of Mostajo & Regaton
grid size = 50m
Ng
SAMPLE SITE
SAMPLE SITE 3
MAP 3:7
Entrance to Regaton
SAMPLE SITE 2
SAMPLE SITE 1
Entrance to Mostajo

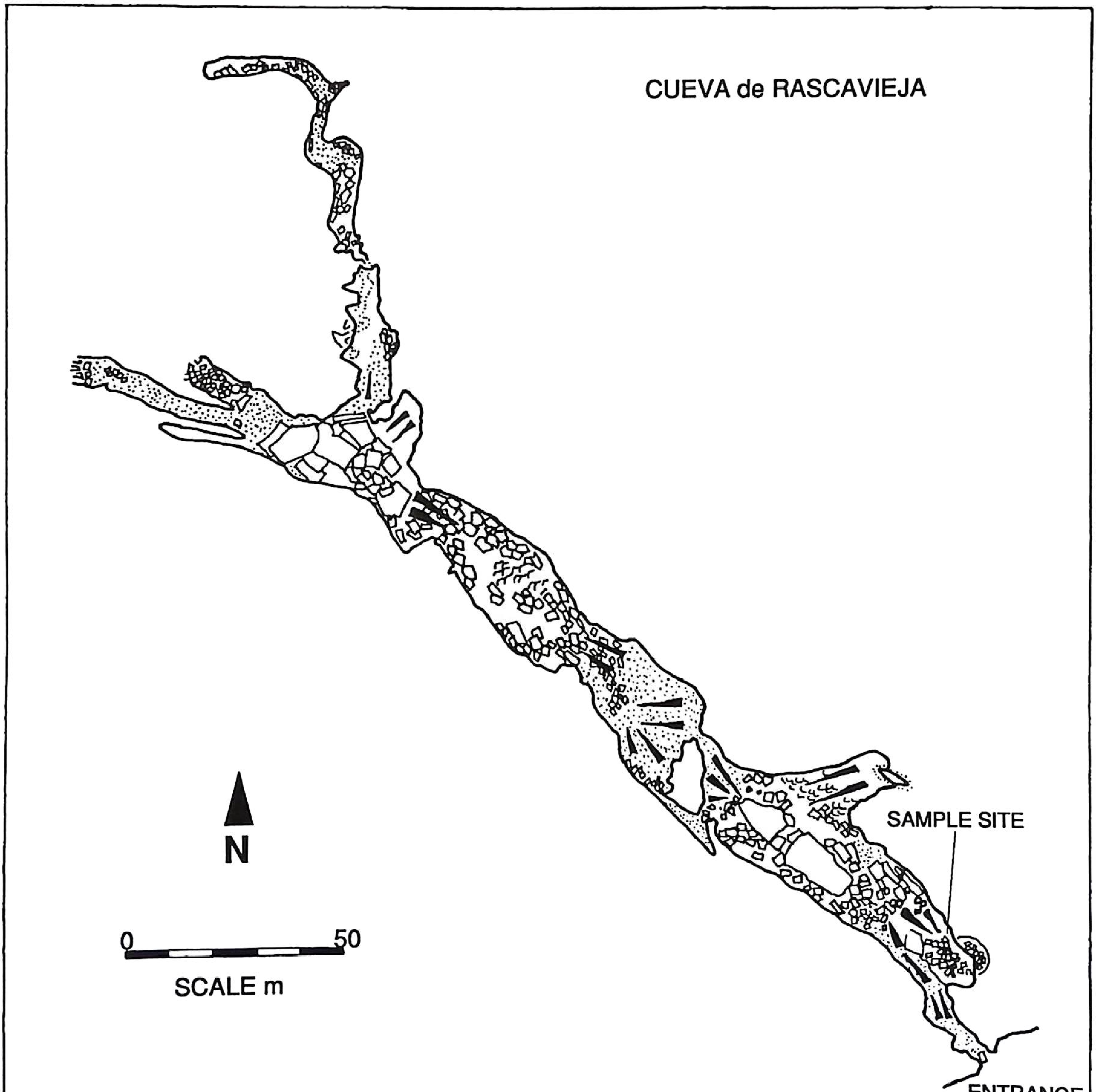
MAP 3:8


Regaton & Mostajo
Projected section on 225° - 45°
Grid size 50m. Vertical exaggeration x2
SAMPLE SITE 1
SAMPLE SITE 2
SAMPLE SITE 3
SAMPLE SITE
Regaton
Mostajo
Altitude: 312m
0
-50
-100

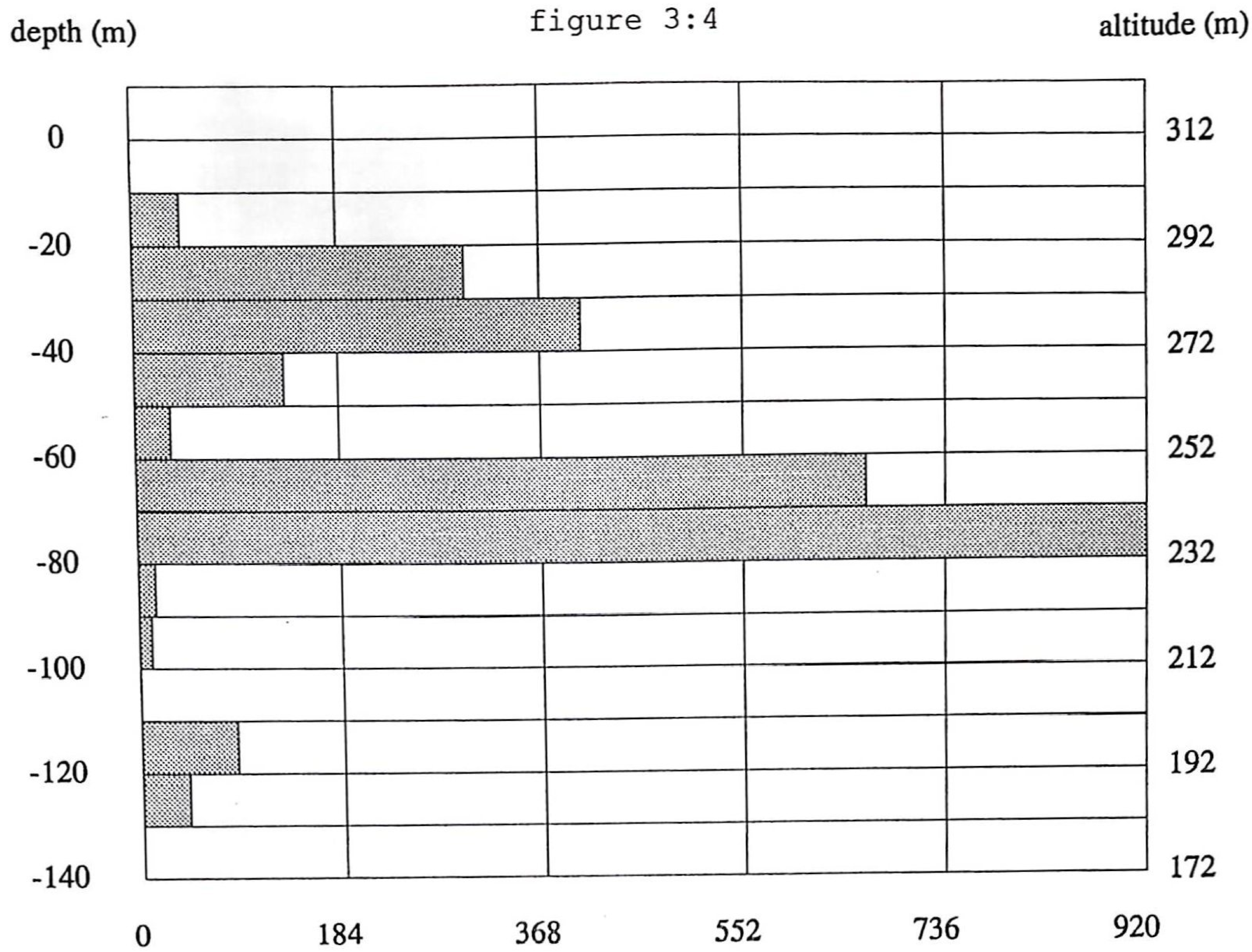
MAP 3:10



MAP 3:9

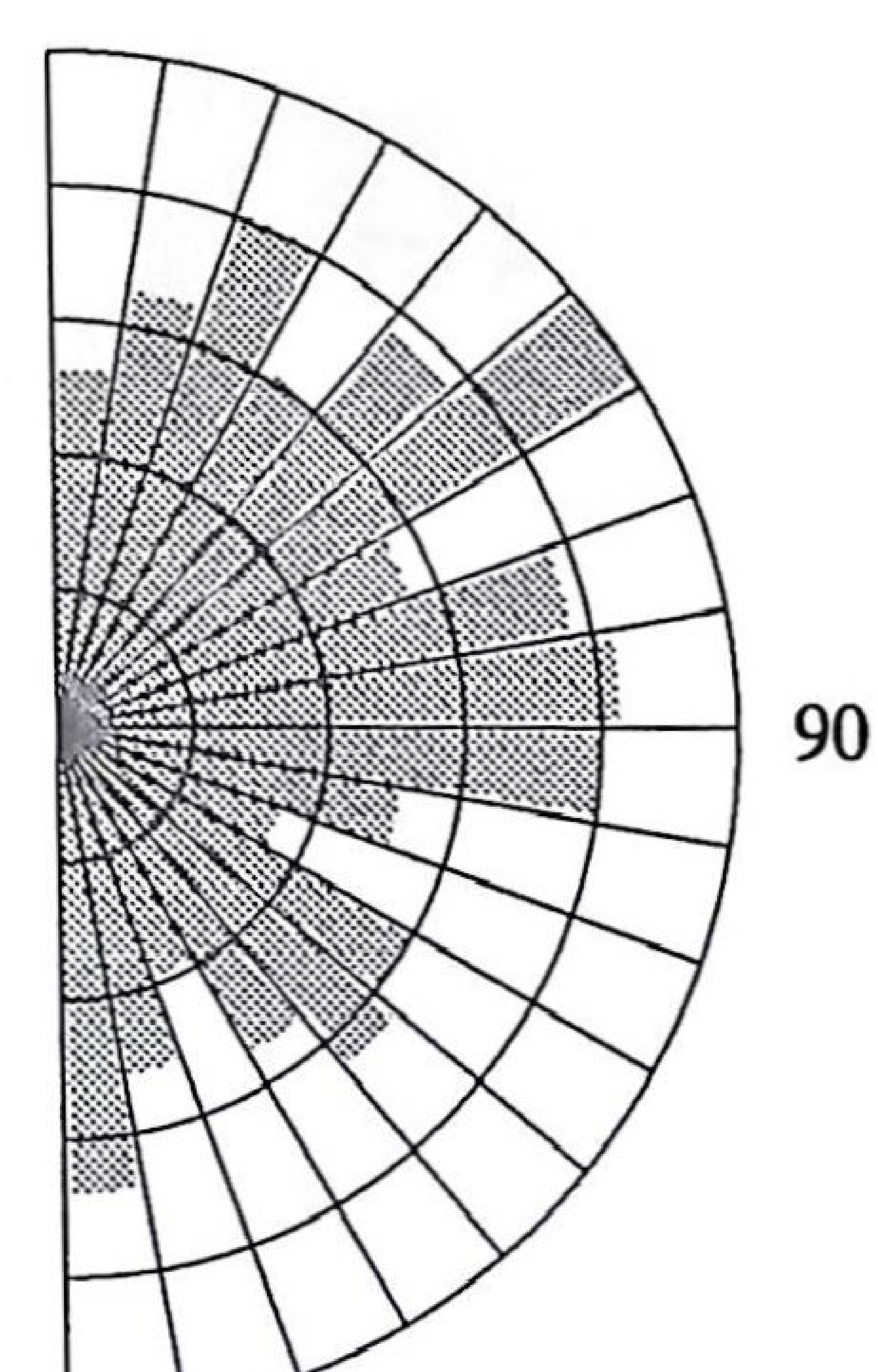


FROM ORIGINALS BY P. SMITH



'Levels' of development for Mostajo (71)

Plan lengths of passages within ±5° of horizontal

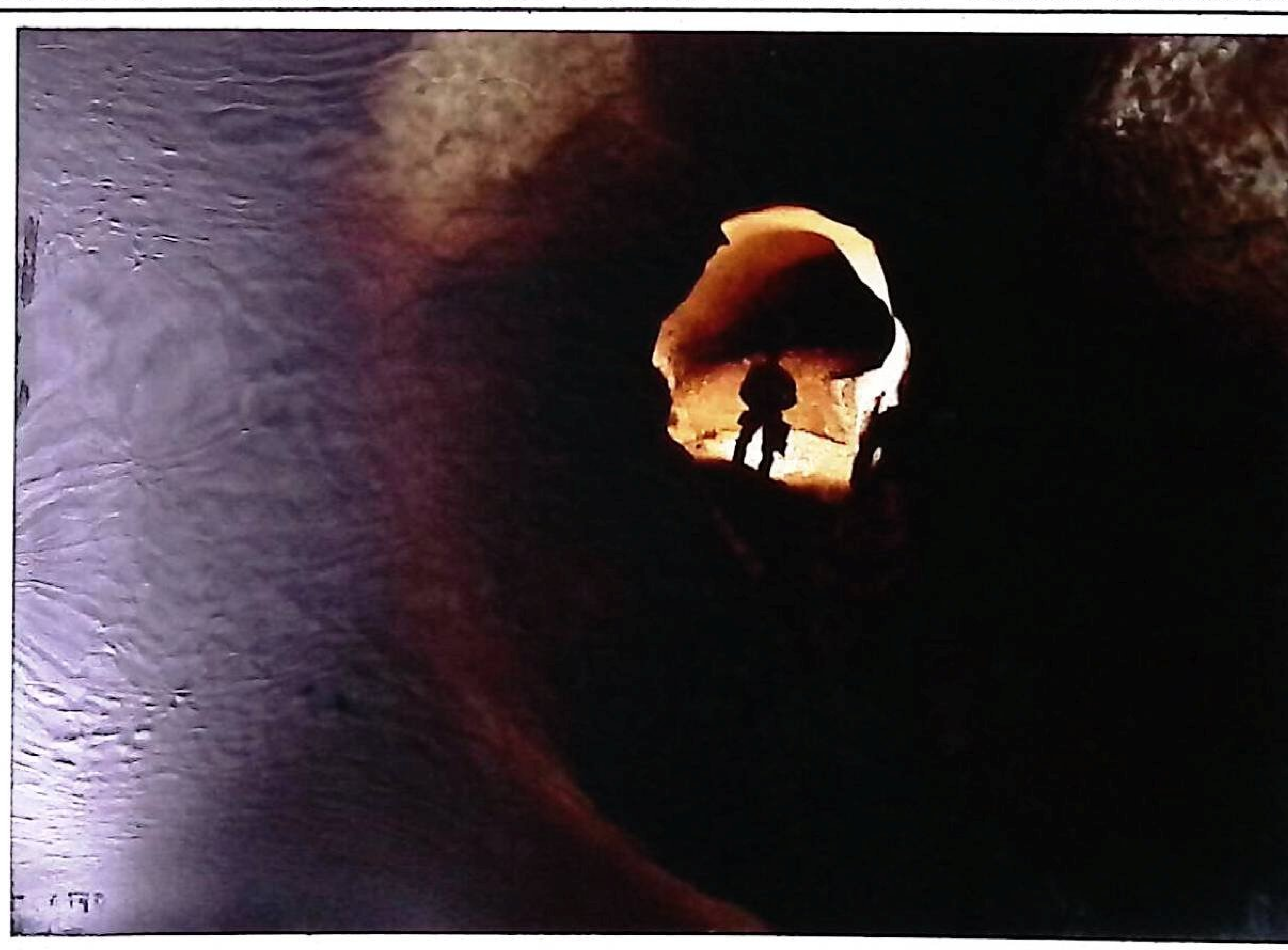


Passage orientation for Mostajo
Radius increment: 92m
Longest length is 464m
between angles of 50 - 60°
in a total plan length of 5358m (8%)

Passage orientation and altitudes: Torca del Mostajo

PLATE 3:3
THE SEDIMENT BANK SAMPLED IN TORCA REGATON.

PLATE 3:4
PHREATIC PASSAGE IN THE LOWER LEVEL OF TORCA REGATON.



3:12. TAKING SEDIMENT CORES.

The sampling device, containing a PVC collection tube, was simply driven vertically into the chosen sediment bank by means of a hammer and hardwood drift. The orientation and inclination of the sample tube were taken and noted utilising the alignment slots situated on the top of the device. The front edge of the sample tube was also marked by indelible pen. Plate 3:5 illustrates the use of the sampling device.

The collected sample of cave sediment was sealed into the PVC tubing at the sample site by means of plastic caps fitted over the ends of the tube and then made fast by a wrapping of insulation tape. Prior to sealing the top of the tube it was trimmed to the level of the collected sediment to prevent any disturbance of the sample in transport between the site and the laboratory. Each sample was marked with indelible pen with the date of collection, site name and number and sample number. The sample point was then surveyed to a known survey station within the cave.

3:13. If the sediment bank was deeper than the 1m long collection tube the following procedure was adopted. Upon completion of the insertion of the topmost sample tube the sediment bank was excavated to the depth of the base of the tube. The sample tube was then removed, secured and marked in the normal way. The base level of the excavation would then present a new surface from which to take a new sample. The top of the second core would then be a continuation from the base of the first. Analysis of the second core can then be considered to be simply an extension of the first.

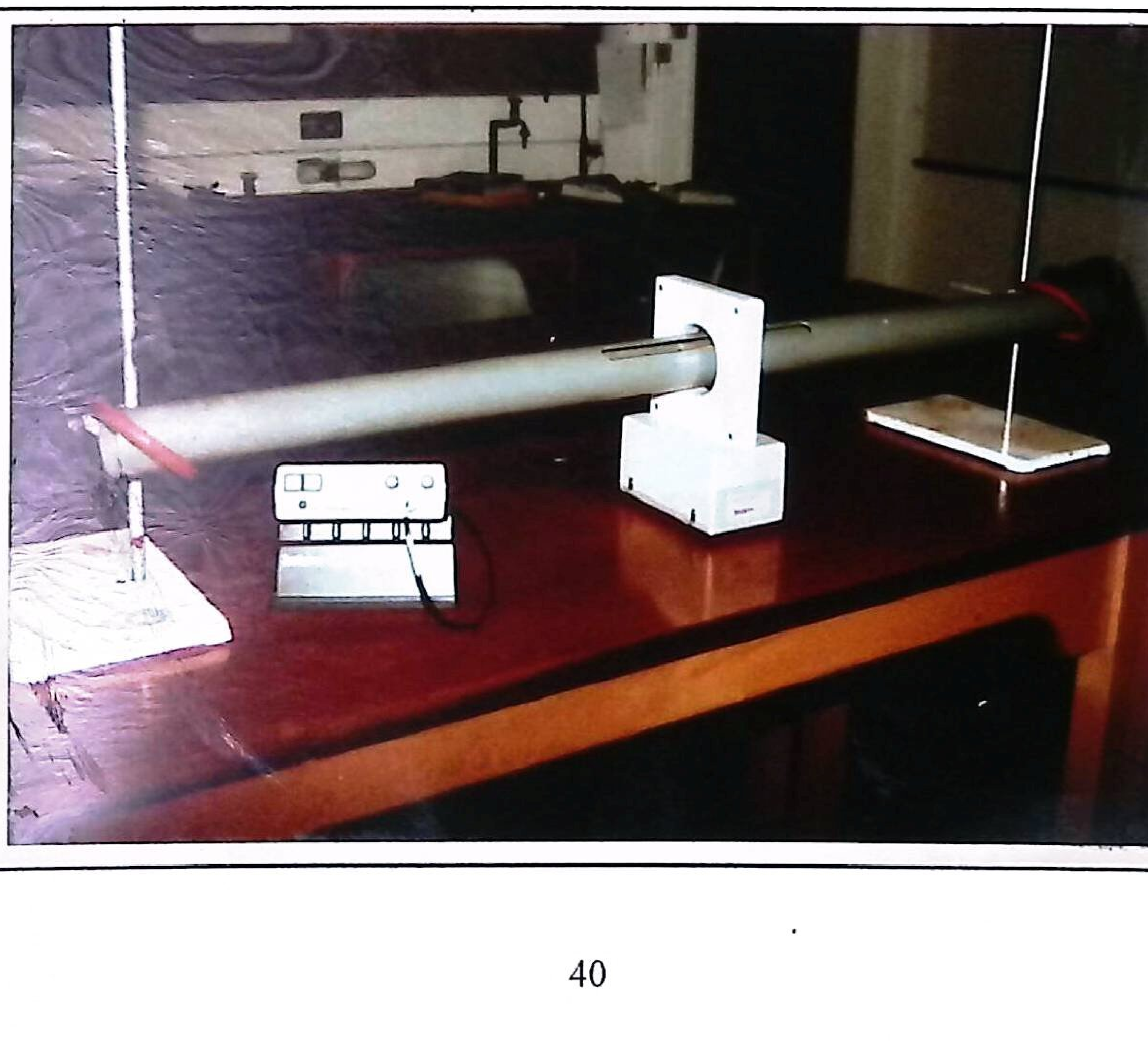
3:14. ANALYSIS FOR MAGNETIC SUSCEPTIBILITY VALUES.

A Bartington MS2 magnetic susceptibility meter fitted with a MS2C core sensor was used to measure the magnetic susceptibilities of the samples. The sensor was mounted on a work bench allowing cores to be passed horizontally through the device.

3:15. The support and positioning of the core through the central axis of the sensor necessitated the design of a holding and guiding device. Again nonferrous materials were utilised. A PVC pipe of 75mm internal diameter and 2m in length served as the tracking along which the core could be moved past the sensor. A window 30cm long cut into the centre of the pipe allowed the correct positioning and progress of the sample to be observed. The tracking was supported at each end by means of retort stands. The height adjustment of these stands allowed the alignment of the long axis of the core sample with the central point of the sensor. This arrangement is shown in plate 3:6.

PLATE 3:5
THE SAMPLING DEVICE BEING USED IN CUEVA de RASCAVIEJA.

PLATE 3:6
TAKING MAGNETIC SUSCEPTIBILITY READINGS FOR THE COLLECTED CORE SAMPLES.



3:16. The calibration procedures recommended by the sensor manufacturer were followed prior to taking any readings. In addition an empty PVC core tube was placed within the influence of the sensor and the system then zeroed. Due to the tendency for magnetic susceptibility readings to drift with temperature changes laboratory temperature was measured and recorded before and after each core was analysed.

3:17. The top of the core was positioned level with the front edge of the sensor and the first reading taken and recorded. Due to the expectation of low variation between successive readings the 0.1 sensitivity range was used. During the collection of cores at some sites colour banding with a thickness of approximately 1cm was observed within the sediment bank. This visual observation of sediment variation led to the decision to measure magnetic susceptibility at 0.5cm intervals along the length of each core thus minimising the possibility of missing a boundary within the core. The core was propelled through the sensor by means of a meter rule simply pushed along the tracking after the sample. This arrangement allowed the 0.5cm interval of readings to be accurately gauged.

3:18. POSSIBLE PALAEOCATCHMENTS.

A study of 1:50000 scale maps of Cantabria led to the identification of several potential catchments that could have been the source of rivers flowing through the Matienzo area. These areas are shown on map 3:2. At this point the effects of Quaternary glaciations in the region should be noted. In particular two present day major drainage routes are attributed to either glacial or post-glacial activity.

3:19. QUATERNARY GLACIATIONS IN NORTHERN SPAIN.

The Rio Ason as it flows through the Ason gorge to the south of Matienzo attained its present day course due to glacial melt water(Mugnier 1969). The Rio Miera to the west of the Matienzo area in its upper reaches flows within a glacially excavated valley. These two spectacular features have captured much of contemporary drainage leading to problems of visually determining more ancient drainage patterns.

Butzer(1981) in his synopsis of the regional Pleistocene for northern Spain quotes evidence of a snow-line altitude of 1200m for the study area. The highest point on the topographic divide around Matienzo is 846m at Cubillos de la Muela Llana, well below any level of glacial activity. The 1200m contour and areas of glacial morraines are shown on map 3:2. The small direct effect of Pleistocene glaciations on Matienzo itself can be illustrated at the entrance to Cueva del Agua found in La Vega valley. Archeological remains dating from 18000 years BP(the end of the last glacial period in northern Spain) have been discovered in an alcove 1m above the present day cave river level(Cueva Del Agua carries the present day valley floor river). It follows that the Matienzo valley floor level has lowered a maximum 1m over the same time period that the Ason gorge has been excavated to a depth of hundreds of meters.

3:20. Sediment samples were taken from four potential palaeocatchments(see map 3:2). The four areas were centred around:- Portillo de Lunada VN468 803; Portillo de la Sia; the upper Miera valley VN440 820; and Valle de Soba VN630 850. The initial three sample sites appeared to be regolith. The latter sample was of modern day fluvial sediments from the Rio Gandara. This site was chosen as the Rio Gandara catchment includes two of the main highlands to the south of Matienzo, Sierra de Hornijo and Picon del Fraile. If these highlands once provided water that passed through Matienzo similar sediments to those found in Matienzo's caves may now be found in the Gandara fluvial system.

3:21. ANALYSIS OF PALAEOCATCHMENT SAMPLES.

Four short sediment cores, each containing material from one catchment, were assembled in the laboratory. These were analysed for magnetic susceptibility values to establish an order of value for susceptibility at each site. Several readings were taken along the core and the mean value calculated, using the calibrations noted in section 4:2.

Standard sieving techniques were also undertaken for each sample to establish grain size distributions. The following sieves were used, all in phi units; 4;3;2;1;0;-1;-2:

Chapter Four

Results and Analysis.

4:1 UNITS AND NOTATION OF MAGNETIC SUSCEPTIBILITY

Magnetic susceptibility is a dimensionless parameter, being dependent on the magnetic field strength causing the magnetisation. However it is often given units to differentiate between susceptibilities based on sample mass or volume. As already stated both SI and CGS units are employed in magnetic measurements. For susceptibility SI units are simply 4pi greater than CGS units.

susceptibility per unit volume (k)
susceptibility per unit mass (X)

the relationship between the two relates to the density (r) of the sample as follows:-

$$X = k/\mathrm{R}$$

The MS2C sensor utilized for this analysis is designed for volume susceptibility measurement. Unless otherwise stated in any further reference to susceptibility the term volume susceptibility k is implied. The values of k obtained are a representation of the proportion of ferrous material within a mineral, from this the mineralogy of samples can be deduced. For the purpose of comparison between cores only their relative values are of concern.

4:2 MAGNETIC SUSCEPTIBILITY VALUES

To obtain a susceptibility reading for the sample (R_s) the measured reading (R_m) from the MS2 susceptibility meter must be corrected to compensate for drift of the machine during sampling and the susceptibility value generated by the PVC tubing containing the sample (Rc).

$$R_s = R_m - (R_c + \text{CUMULATIVE DRIFT})$$

In all cases $R_c = 0.4$

The drift is calculated by zeroing to air before any readings are taken and then taking a reading to air after the final core reading to give the total drift. The total drift divided by the number of readings taken for a core will give the mean drift over each reading. The drift correction is the cumulative drift at each reading along the core, the final drift correction will be the total drift.

MEAN DRIFT = TOTAL DRIFT / NUMBER OF READINGS

The ambient laboratory temperature variation over the period of any sampling session had a maximum value of

0.5^oC. This is well within the temperature fluctuation tolerance of 2^oC set by the manufacturer before any temperature controlled correction is required.

The sample reading must also be corrected to give a value of magnetic susceptibility (k). This is to compensate for effects caused by the relationship between the core diameter (d) and the sensor coil diameter (D). A calibration graph(see appendix 3), plotting d/D against $K_{relative}$, is provided by the manufacturers for this purpose. For the coil and core diameters used throughout the analysis the following correction was used to give corrected susceptibility values:-

$$d = 42mm$$

$$D = 88mm$$

$$d/D = 0.477$$

from the calibration curve $k_{rel} = 0.48$

$$R_s \times k_{rel} = k$$

A full list of values of k obtained for each core along with R_m, R_s, mean drift and R_c corrections and k_{rel} calibrations are given in appendix 4.

4:3 VARIATIONS IN MAGNETIC SUSCEPTIBILITY VALUES.

Variations in the magnetic susceptibility values of sediment are a reflection of the variable ferrous content of their component minerals. Sediments with high ferrous content having accordingly high susceptibilities. The mineralogy of a sediment will alter along with the following conditions.

The variation in magnetic susceptibility found down a soil profile is described in section 1:4. The effect of changing rates of erosion processes within a catchment on susceptibility values of sediments found downstream are also described in section 1:4. Susceptibility will also vary spatially with changing lithology of the underlying bedrock. Changes in the geochemical make up of a catchment will also occur as the catchment is progressively eroded downwards. A single rock unit will not be homogeneous and new rock strata will be exposed as the land surface is denuded.

The magnetic susceptibility values of sediments derived from within these changing conditions will vary correspondingly. In summary the magnetic susceptibility of a sediment will be dependent on the following factors:-

(1) The geographical location of the source catchment.
(2) The length of time that erosional processes have been acting upon an area.
(3) The rate of erosional processes.
(4) The position from within a soil profile from which sediment material is derived.

4:4 COMPARISON OF MAGNETIC SUSCEPTIBILITY VALUES FOUND IN THE SAMPLE CORES.

The comparison of magnetic susceptibility profiles along sediment cores is to some degree dependent on the values recorded for these cores. If a similar range of values are recorded for each sample the position of peaks of high susceptibility are likely to be of most interest. The relative position along the length of the cores of peaks, representing a characteristic change in sediment supply, could be compared at various points along the fluvial system. A similar pattern of peaks in susceptibility, but varying in position, may be present in cores taken from different locations along the same fluvial system.

The range of susceptibility values recorded may however differ between sets of samples. In this case sample sites can be grouped according to similarities in their susceptibility ranges.

4:5 SUSCEPTIBILITY VALUES FOR CORES FROM EACH SITE.

For the purpose of this analysis samples Mostajo 2A and 2B are considered as one core as are Regaton 1A and 1B. The depth of sediment at the sample site made the extraction of a single core impossible, the measures described in section 3:13 were used to ensure continuity of sample collection.

figure 4:1 **LIST OF SAMPLE SITES AND CORE LENGTHS.**

CAVE	SITE NUMBER	CORE NUMBER	CORE LENGTH (cm)
COTERON	1	1A	49
COMELLANTE	1	1A	41
ARENAL	1	1A	35
REGATON	1	1A	83.5
REGATON	1	1B	53
MOSTAJO	1	1A	36
MOSTAJO	2	2A	88
MOSTAJO	2	2B	66
MOSTAJO	3	3A	64.5
COBERRUYO	1	1A	54.5
RASCAVIEJA	1	1A	29

COTERON.

Little variation of the susceptibility values were recorded along the length of this core. Maximum value 1.8, minimum value 0.5, giving a range of 1.3.

MOSTAJO 1.

Little variation of susceptibility values were recorded for this core. Maximum value 1.5, minimum value 0.7, giving a range of 0.8.

MOSTAJO 2.

Again little variation of susceptibility along the core. Maximum value 1.1, minimum value 0.4, giving a range of 0.7.

MOSTAJO 3.

Little variation observed along the core. Maximum value k = 1.6, minimum value k = 1.2, giving a range of 0.4.

ARENAL.

Susceptibility values rise steadily along the length of the core until a peak value of 11.2 is reached. The values fall steadily over the remaining length of the sample. The minimum value obtained was 0.6 giving a range of 10.6. Values remained low and relatively constant for the first 12cm of the core when they begin to rise to the 11.2 level reached at 16.5cm. Susceptibility values return to their lower levels after 26cm. Three zones of differing susceptibility can be identified. Zone 1(0 to 12cm) low susceptibility; Zone 2(12 to 26cm) relatively high susceptibility; Zone 3(26 to 35cm) low susceptibility values similar zone 1.

COMELLANTE.

Steadily rising susceptibility values rising from 1.7 at the beginning of the core peak at 8.0 after 21cm. Values steadily decrease over the remaining length of the core. The range of k values for this site is 6.3.

COBERRUYO.

Five zones of k values can be distinguished along the length of this core. Zone 1(0 to 13.5cm) little variation in values with an average value k=2.5; Zone 2(13.5 to 17cm) values drop below 1.8 with a minimum of 1.1 at 15.5cm after which they rise again; Zone 3(17 to 45cm) values steady at around 2.1. Minor peaks occur at 20cm and 32cm both with susceptibility values at 2.6, the low point between these peaks, 27cm, has a value of 1.9; Zone 4(45 to 48cm) values below 1.8 with a minimum of 1.7; Zone 5(48 to 54.5cm) values rise to a maximum for the core at 3.9 two centimetres before the end of the sample.

RASCAVIEJA.

The 29cm of this core can be considered as one zone. Values rise from 1.6 to a maximum of 3.3 at 15cm. Between 13 and 20cm all k values are either 3.2 or 3.3. Values of k fall steadily between 20cm and the end of the sample where k = 1.6.

REGATON.

Three zones of susceptibility values can be identified. Zone 1(0 to 83cm) susceptibility values rise steadily from 1.9 at the beginning of the core to a value of 14.5 at 30cm after which they fall to 7.5 at 35cm before rising again to 12.9 at 39.5cm. They decrease once more to a value of 2.1 at 83cm. This decline is uneven with slight upturns visible with peaks at 65 and 79cm with k values of 3.4 and 2.9 respectively; Zone 2(83 to 98cm) has k values below 1.8 with a minimum value of 1.2 occurring at 85cm; Zone 3(98 to 136.5cm) the highest susceptibility values from any cores were recorded from this section. Values rise from 2 at the start of the zone to a peak of 24.2 at 113cm after which values decline slightly to a minimum for the zone of 18.9 at 115cm. Values again rise reaching a maximum of 41.2(highest recorded value) at 125cm, values decline to 12.1 at the end of the core.

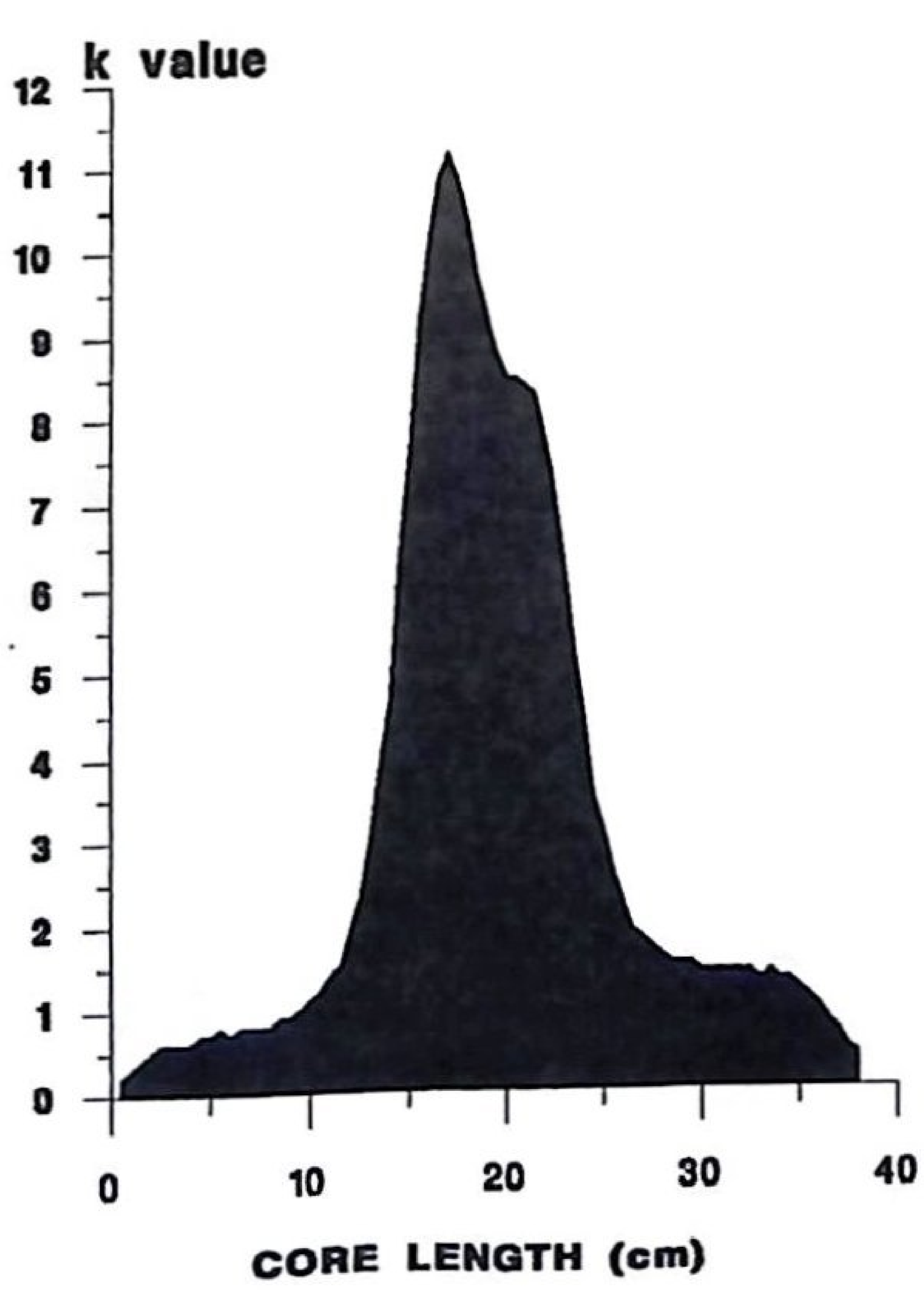
figure 4:2 MAXIMUM, MINIMUM AND THE RANGE OF MAGNETIC SUSCEPTIBILITY VALUES FOR THE CAVE SITES.

CAVE	MAX k	MIN k	RANGE
ARENAL	11.2	0.6	10.6
COMELLANTE	8.0	1.7	6.3
COBERRUYO	3.9	1.1	2.8
RASCAVIEJA	3.3	1.6	1.7
COTERON	1.8	0.5	1.3
MOSTAJO 1A	1.5	0.7	0.8
MOSTAJO 2A/B	1.1	0.4	0.7
MOSTAJO 3A	1.6	1.2	0.4
REGATON 1A/B	41.2	1.2	40.0

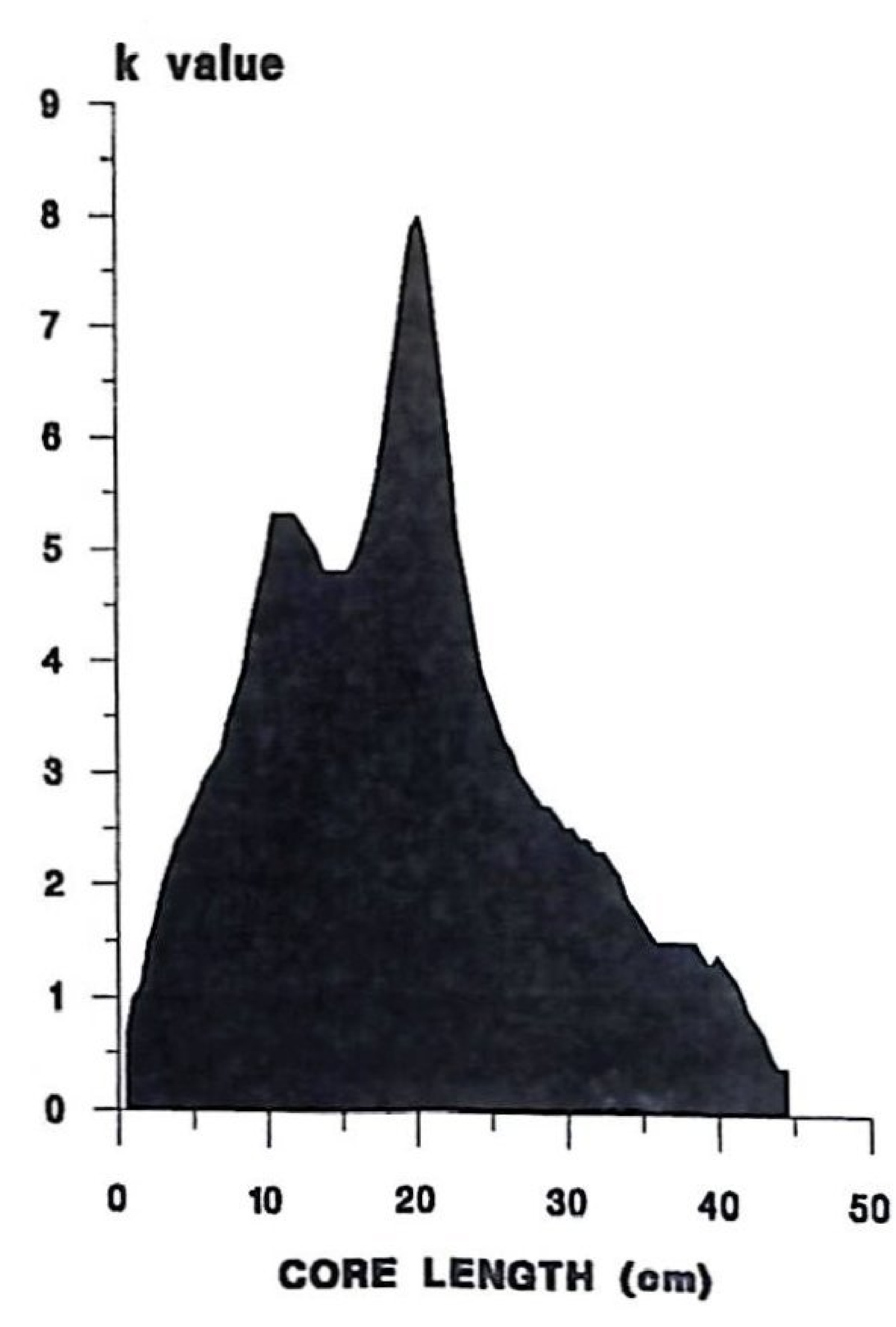
Graphs of core lengths against *k* value for all sites are presented below. The cores are grouped according to the range of the *k* values, these groupings are discussed in section 5:3.

GROUP 1

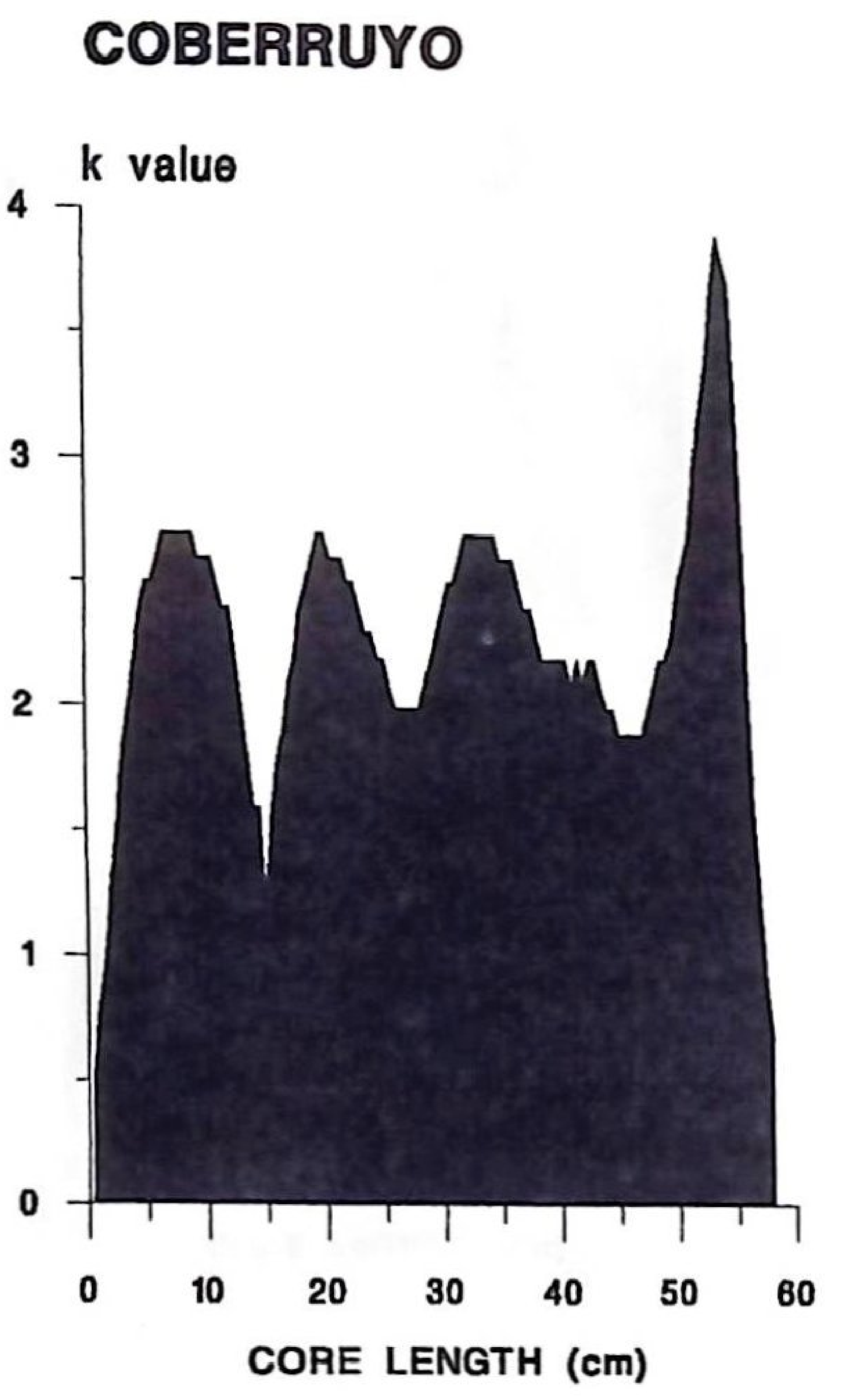
ARENAL

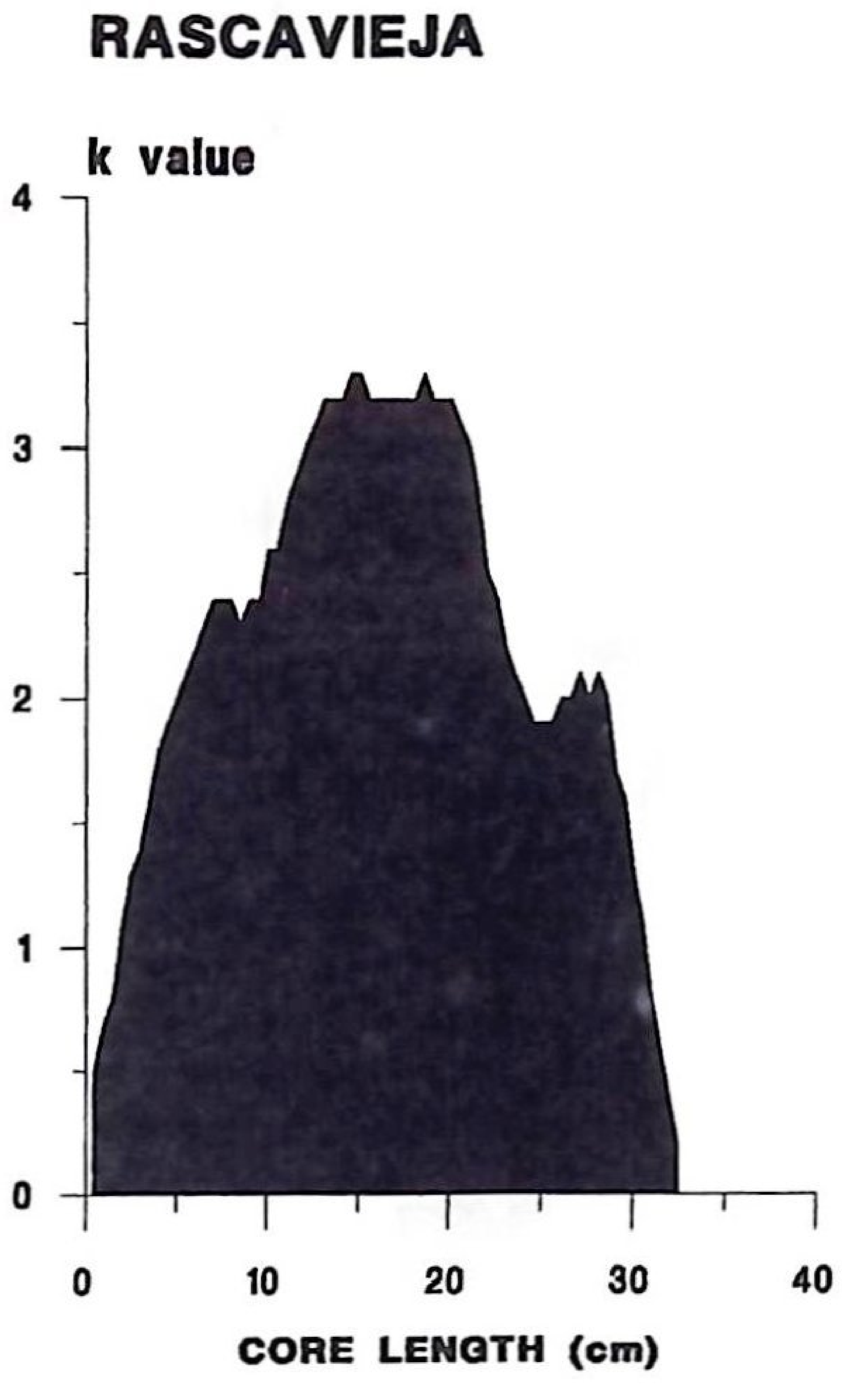


COMELLANTE

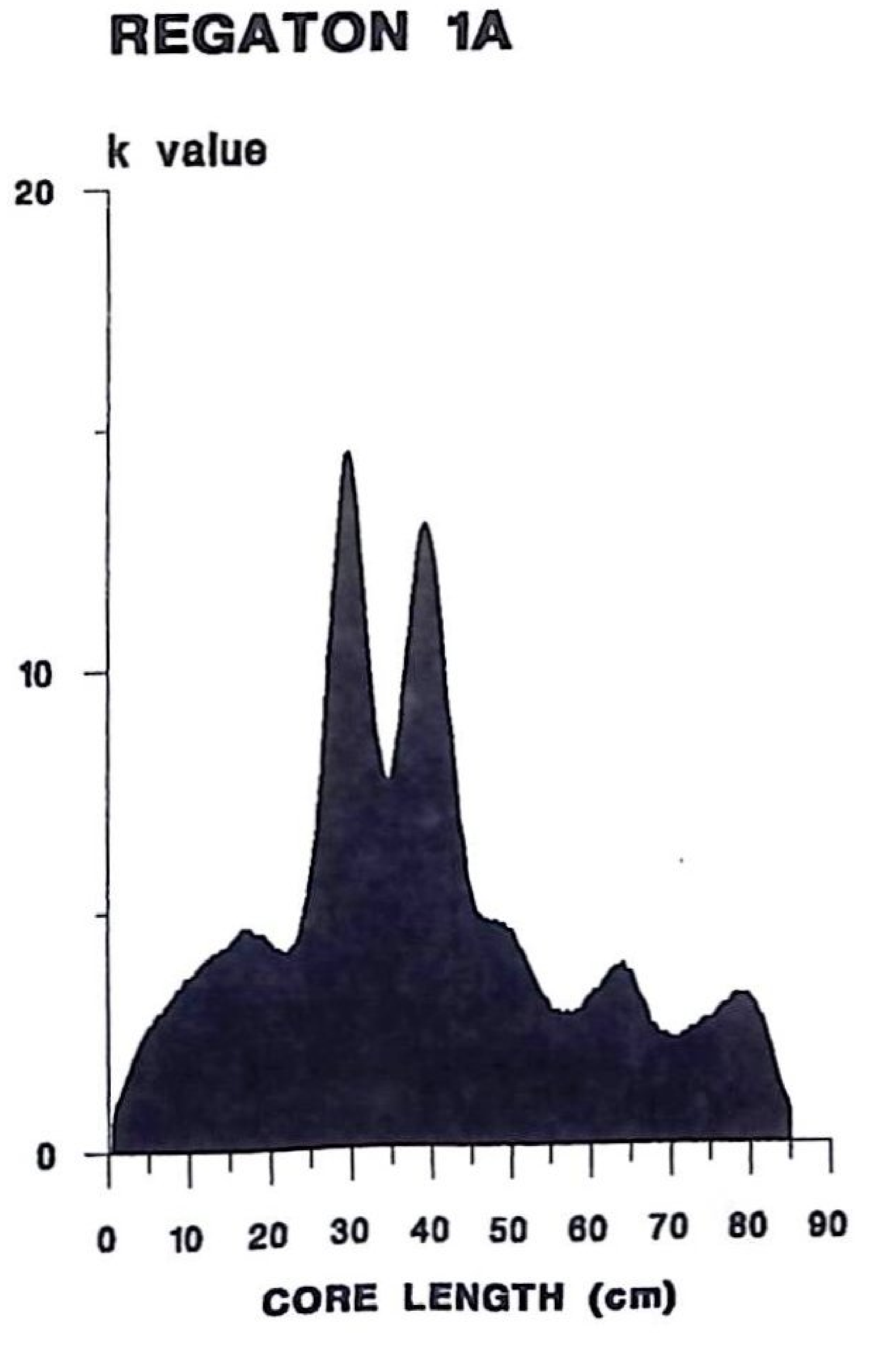


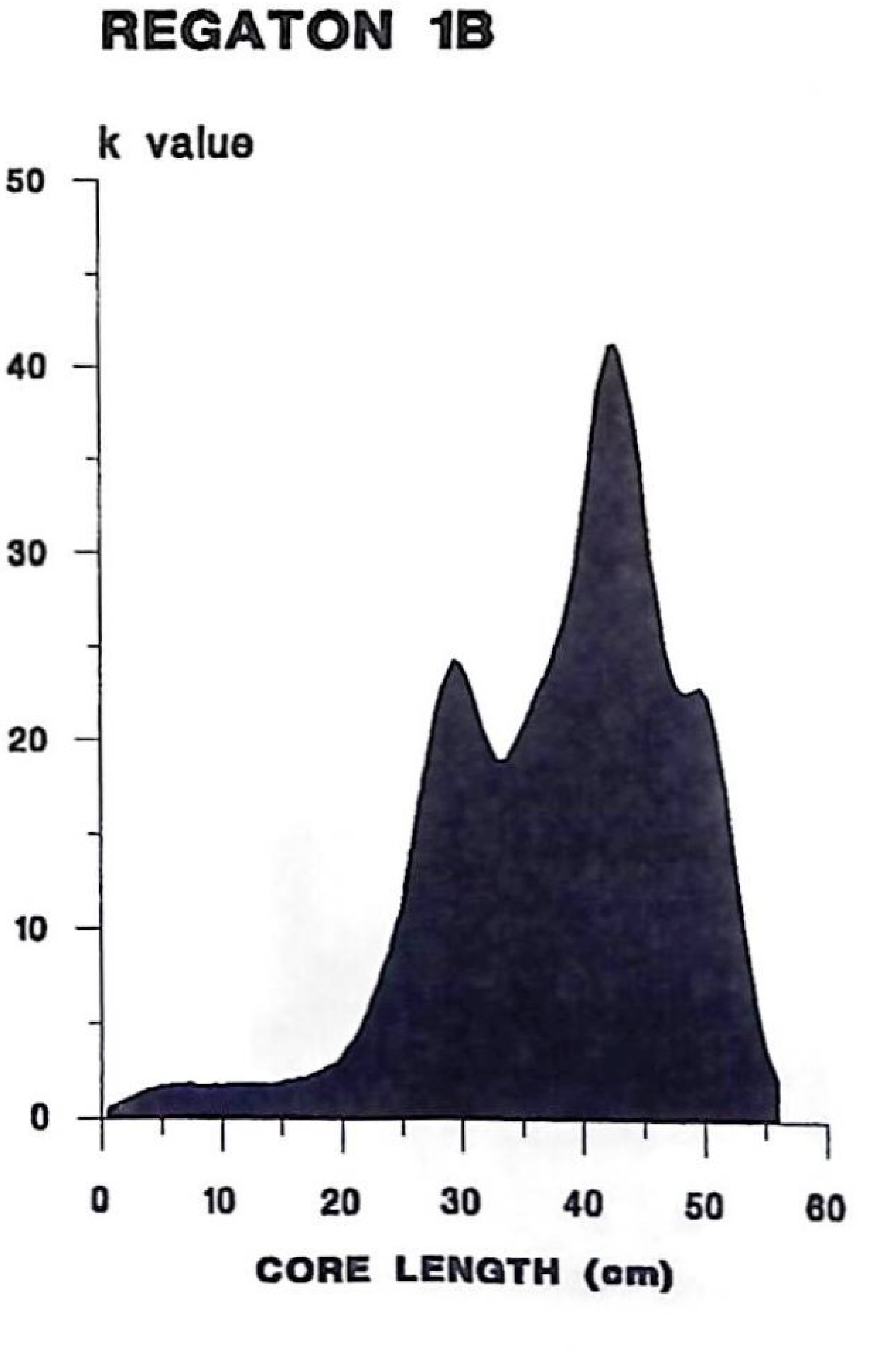
GROUP 2





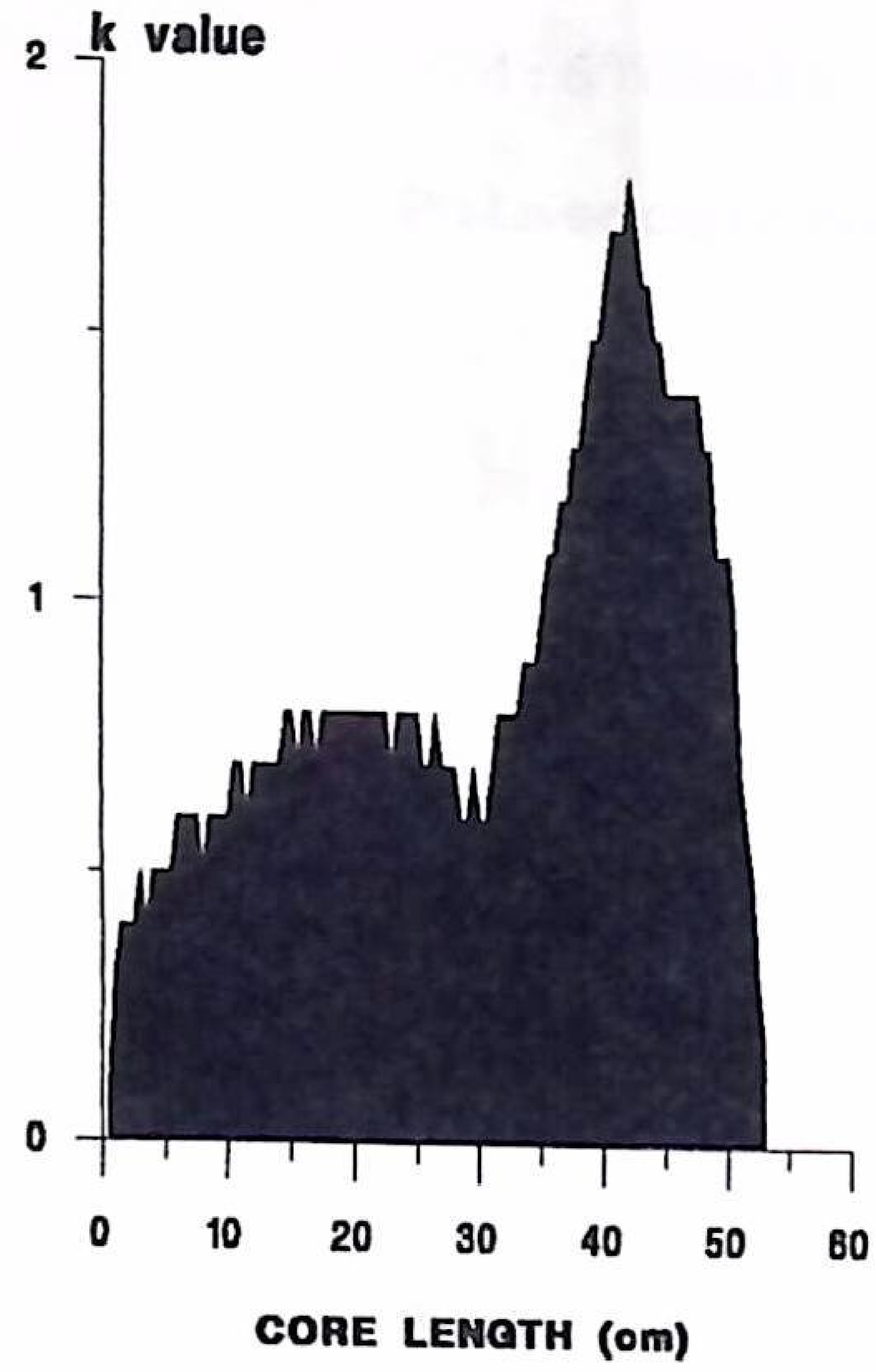
GROUP 4



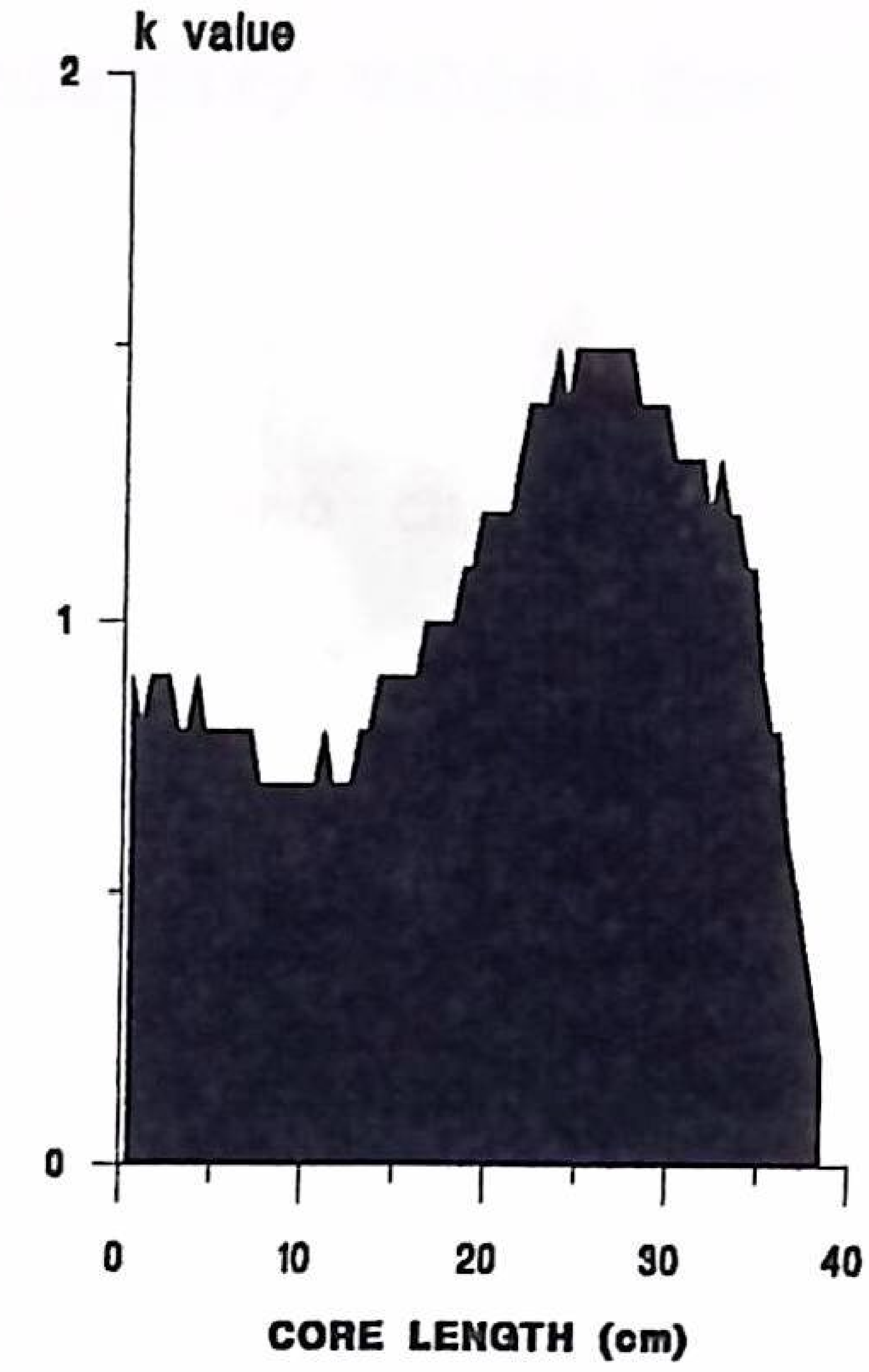


GROUP 3

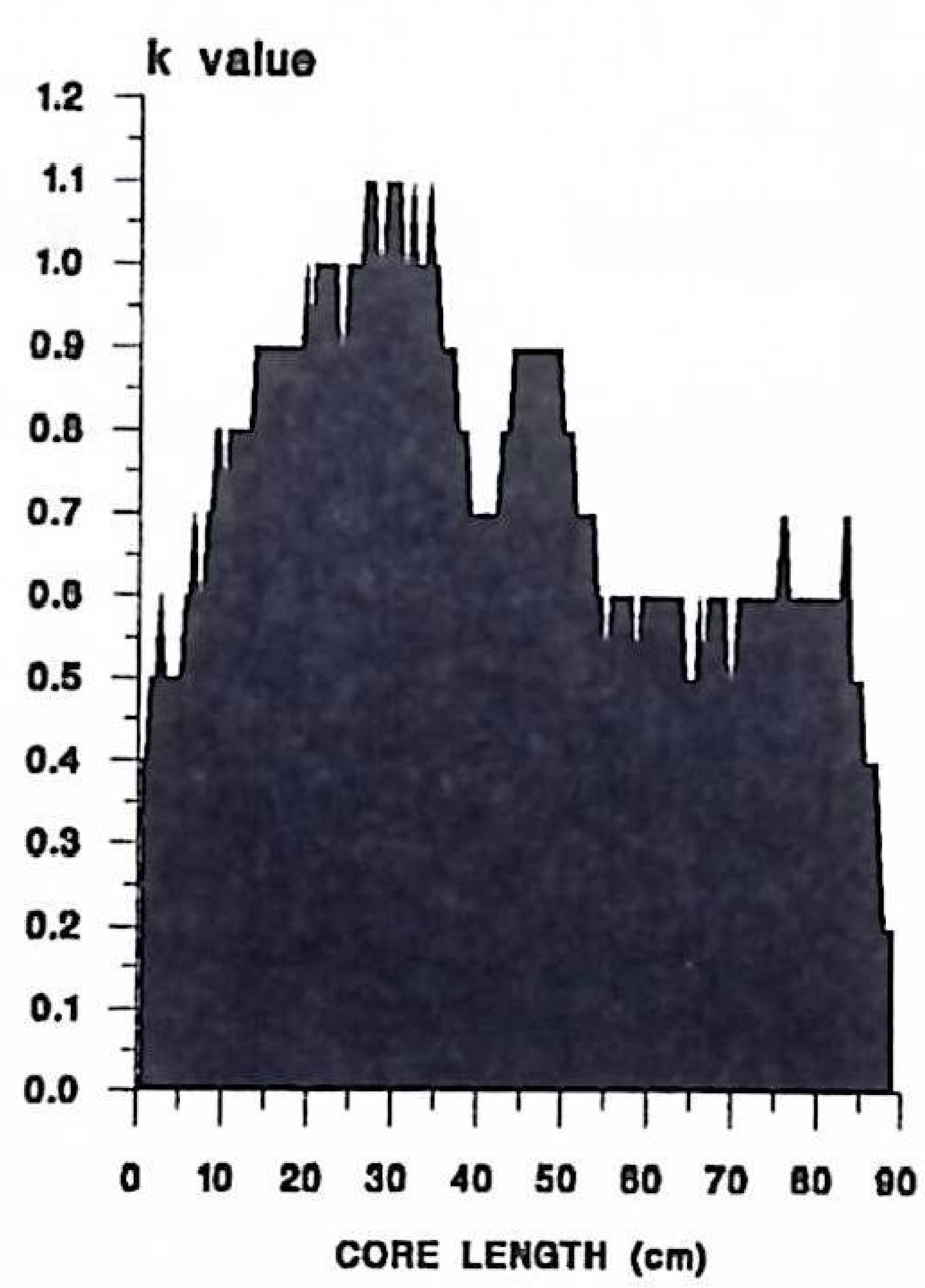
COTERON



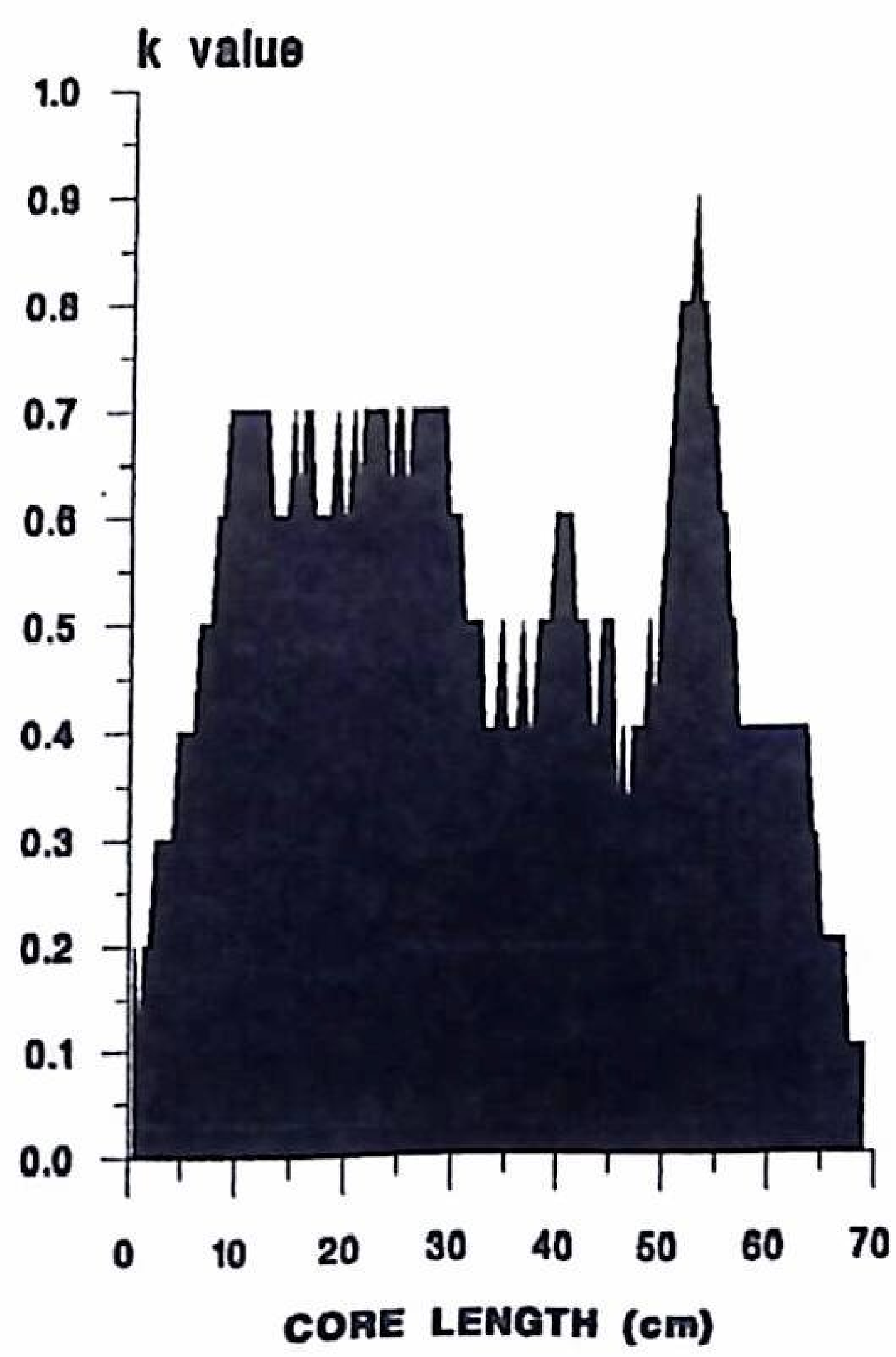
MOSTAJO 1A



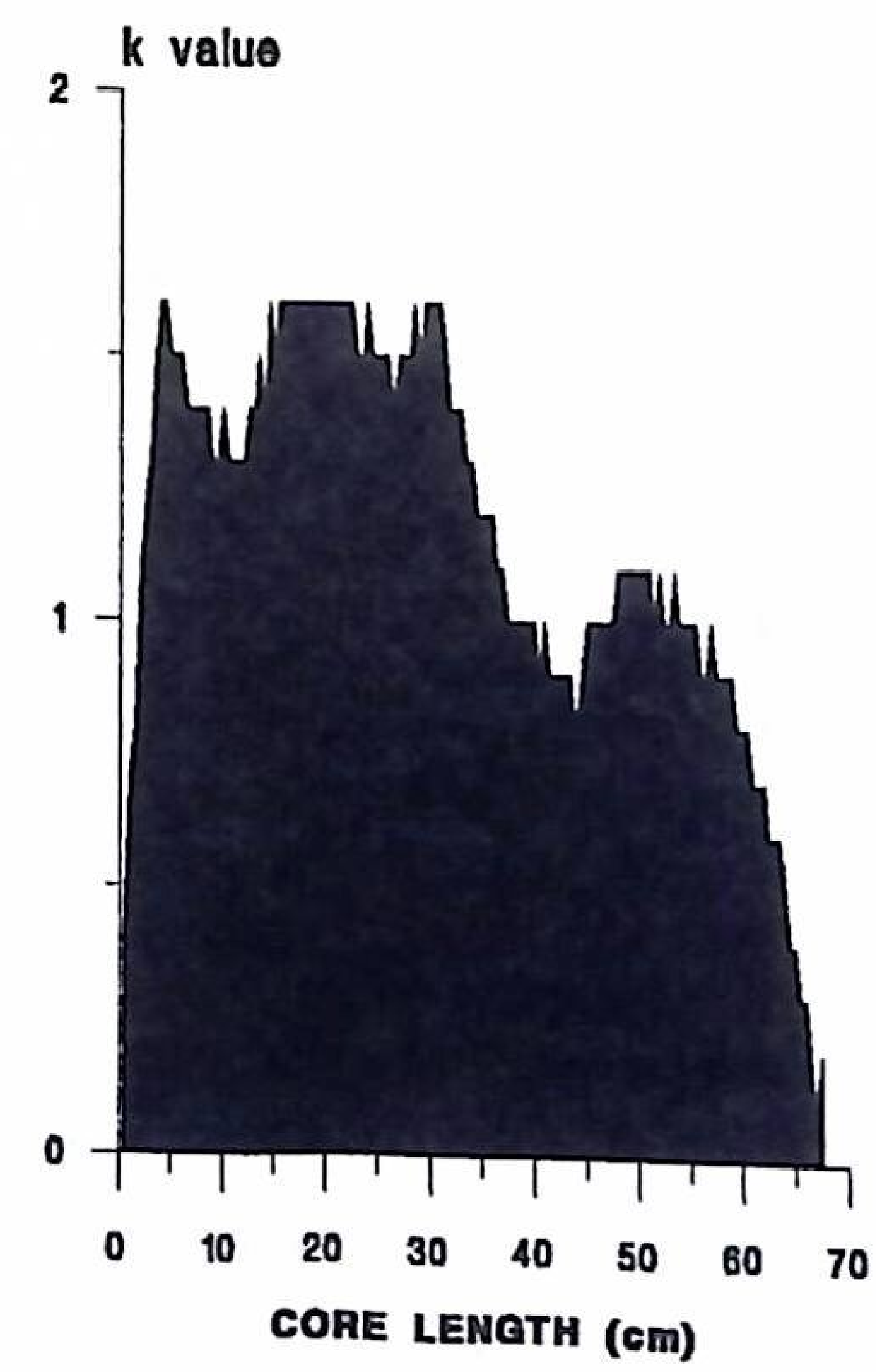
MOSTAJO 2A



MOSTAJO 2B



MOSTAJO 3A



4:6 Grain Size Analysis and Susceptibility Values for Palaeocatchment sites.

Portillo de Lunada, Portillo de la Sia and the upper Miera valley catchment cores all had low magnetic susceptibility values, 0.3, 0.7 and 0.7 respectively. The sample taken from the Valle de Soba had a *k* value of 3.5. Magnetic susceptibility values for the catchments are shown in figure 4.4 and the grain size distributions in figure 4.3. Grain size distribution is also illustrated graphically overleaf.

figure 4:3 GRAIN SIZE DISTRIBUTION FOR CATCHMENT SAMPLES.

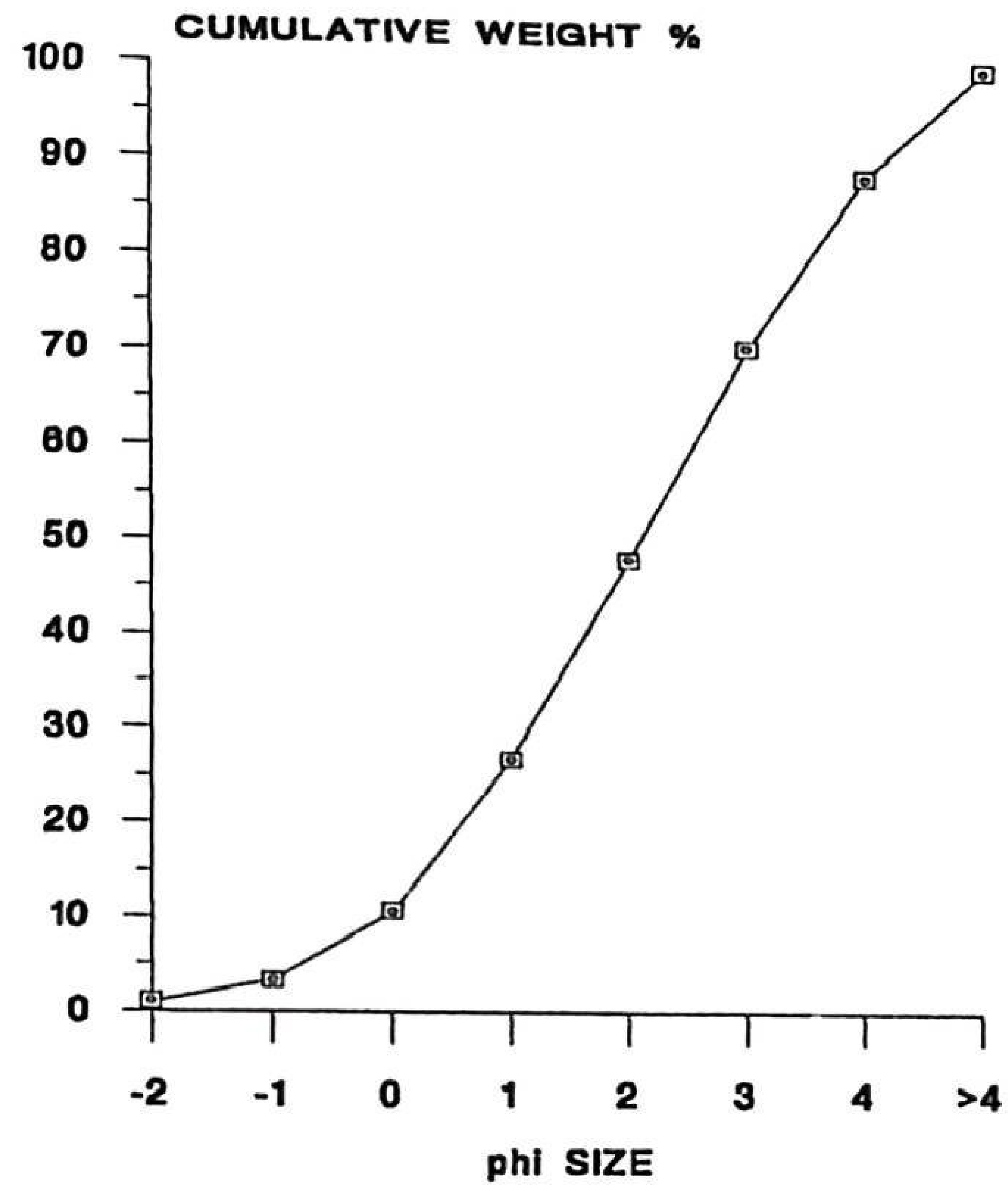
NAME OF CATCHMENT	% OF GRAIN SIZE FOR EACH PHI UNIT							
	>4	4	3	2	1	0	-1	-2
Portillo de Lunada	11.5	18.0	22.8	21.1	16.2	7.4	2.2	1.0
Portillo de la Sia	5.2	8.6	12.0	5.8	6.8	9.6	20.6	31.2
Upper Miera Valley	9.0	11.6	23.0	26.2	9.0	4.7	3.0	13.4
Valle de Soba	5.0	4.5	7.0	12.0	16.8	15.4	9.0	30.4

figure 4:4 MAGNETIC SUSCEPTIBILITY VALUES FOR CATCHMENT CORES.

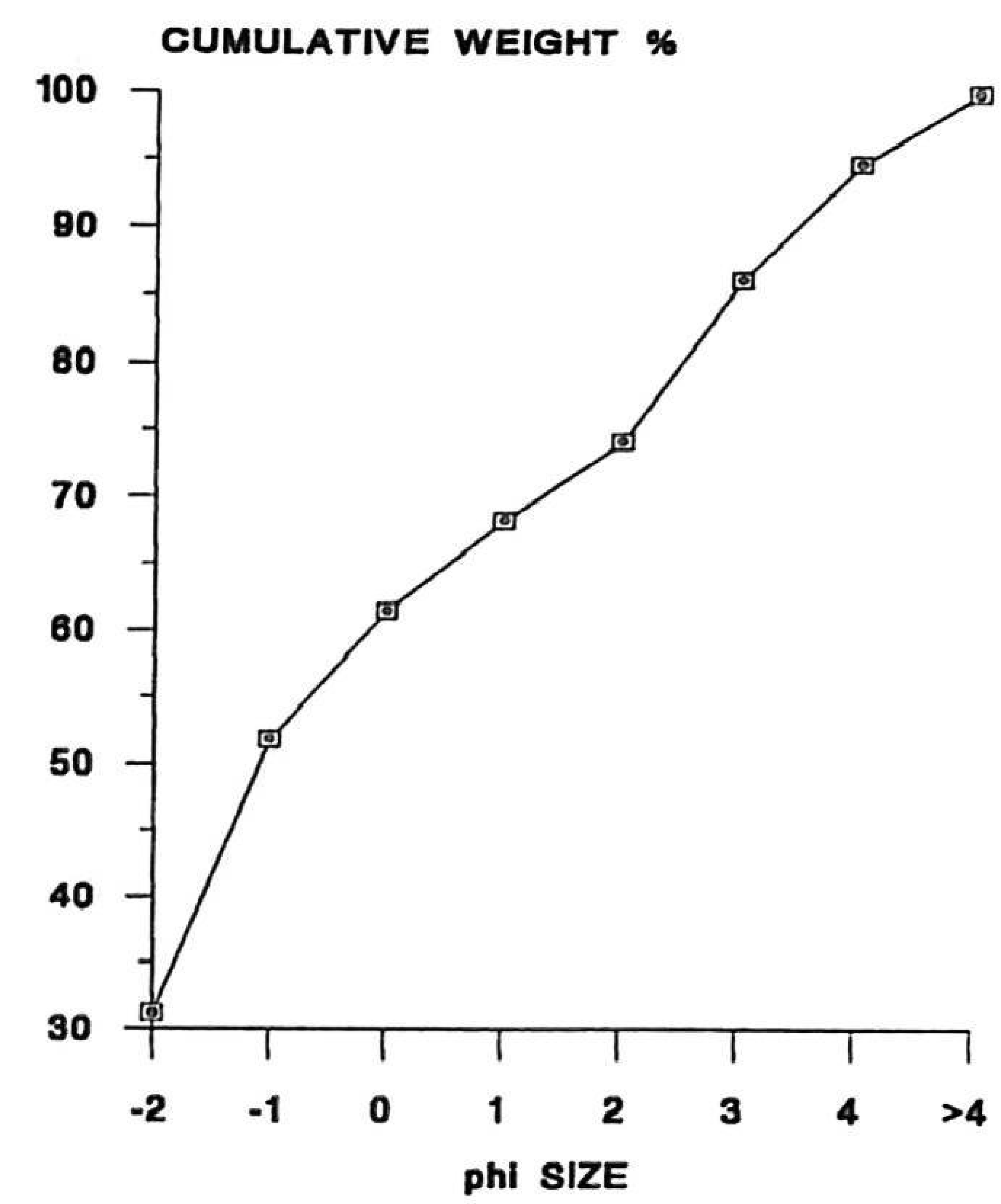
NAME OF CATCHMENT	MEAN *k* VALUE
Portillo de Lunada	0.3
Portillo de la Sia	0.7
Upper Miera Valley	0.7
Valle de Soba	3.5

CUMULATIVE CURVES FOR GRAIN SIZE DISTRIBUTIONS FROM THE PALAEOCATCHMENT SAMPLES.

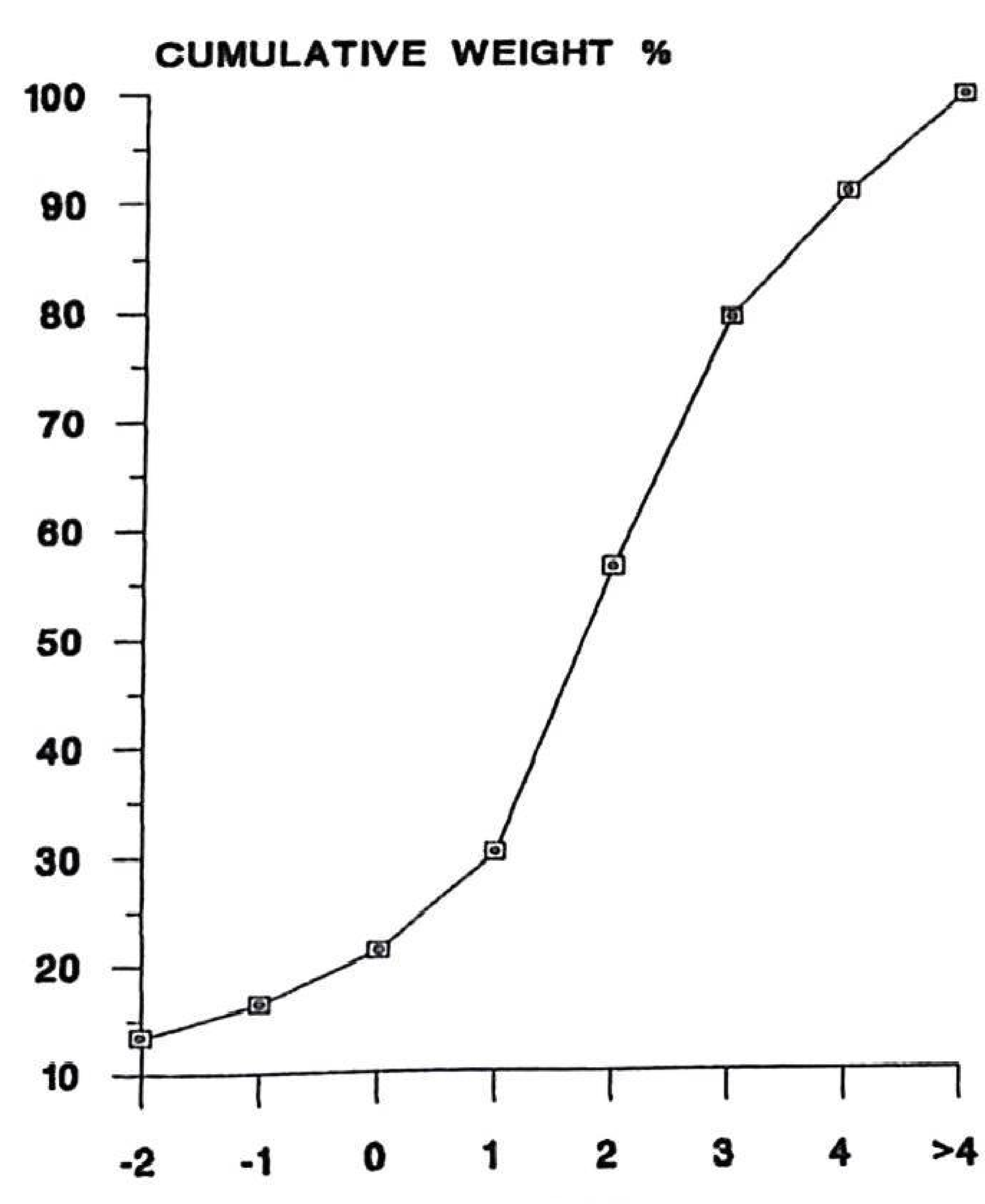
PORTILLO de LUNADA



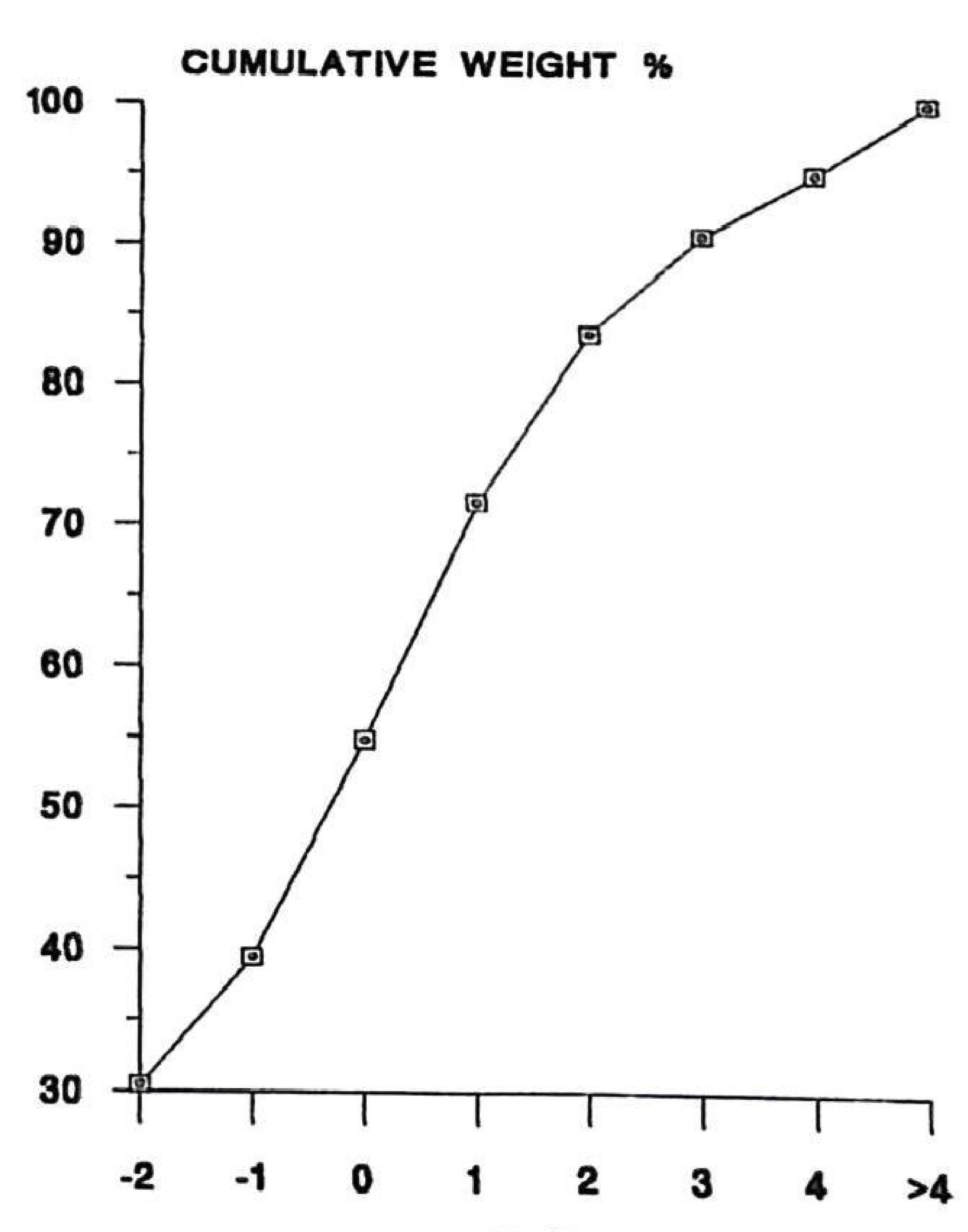
PORTILLO de la SIA



UPPER MIERA VALLEY



VALLE de SOBA



Chapter Five

CONCLUSION.

5:1 The magnetic susceptibility values obtained along the length of each core suggest that the design, manufacture and implementation of the sampling method and sampling tool was successful and relevant to the research question at hand. Clear trends in the variation of these values are seen in each core. If the sediment had been disturbed or magnetism induced during the collection and transport of cores a more random distribution of k values would have resulted.

5:2 The general conclusion to be drawn from this study is that broad similarities exist in magnetic susceptibility values for sediment cores taken from caves in the Vega arm of the Matienzo depression. All the values of k recorded for the cores suggest that clay minerals form a significant proportion of the sediments. This is not an unexpected finding due to the dominant occurrences of clays in general and their tendency to be transported in suspension within a fluvial system. The purpose of this study was not however to determine the specific mineralogy of deposits but to compare specific properties of deposits from various sites.

5:3 In considering the values and range of magnetic susceptibility for the sample sites the caves can be divided into four groups each with comparable results:

GROUP 1. Arenal and Comellante have relatively high minimum and maximum values for *k* and a correspondingly relatively large range.

GROUP 2. Coberruyo and Rascavieja have a comparatively small range of k values with both maximum and minimum *k* values being relatively low.

GROUP 3. Coteron and all sites within **Mostajo.** Very low maximum *k* values and a small range.

GROUP 4. Regaton high maximum *k* values and similar minimum k values to all the other sites highlighted by the large range of values recorded.

5:4 Some immediately obvious similarities between the caves within each group are apparent. The caves in group 1, Arenal and Comellante are both active resurgences and will therefore be supplied with present day sediments. No hydrological link is however known between these two sites.

Coberruyo and Rascavieja, in group 2, are both situated in similar positions and identical altitudes on the northern slopes of the Vega valley. Both appear to be small isolated sections of now fragmented larger systems, possibly once connected.

Group 3, Coteron and Mostajo, are situated on opposite sides of the valley. Their passages however bear some resemblance to each other. Large abandoned tunnels with large quantities of sediment deposits are a feature of both caves. In areas of both caves extensive calcite and gypsum deposits are common. The major development of both caves lie between 230m and 240m altitude.

Regaton, in group 4, is unusual for the area in having considerable horizontal cave passage development at such a low altitude(180m). The values of k found here compared to those found in Mostajo are quite surprising, considering their close proximity. No other sites produced comparable results.

5:5 The mean susceptibility values obtained for the four catchment areas can be divided into two groups.

Group 1 containing Portillo de Lunada, Portillo de la Sia and the Upper Miera valley have low mean k values similar to those found in group 3 of the cave sites.

Group 2 the Valle de Soba has a *k* value matching those of Coberruyo and Rascavieja in group two of the cave sites.

5:6 DISCUSSION.

Various explanations can be put forward to explain the findings of this study, the main points are debated below.

Caves with similar ranges of magnetic susceptibility values in their sediment records, Arenal and Comellante; Coberruyo and Rascavieja; Coteron and Mostajo, may have derived those sediments from a common source. Alternatively two or more source areas of similar characteristics may have supplied sediment material.

It could be argued that even if a common morphogenic agent formed two caves they could still have developed independently of each other. This would be the case if a river passing through one cave then resurged into a valley floor and later entered the second cave. Several points indicate that this did not occur. Caves formed by a sinking river often have vadose characteristics such as notches or incised trenches, these are absent from the caves in question. More convincingly the general direction of hydrological flow in the region is from south to north, evidence of scallop markings within Matienzo's caves support this hypothesis. The proposed links between Coteron and Mostajo have lower altitudes of passages to the south, in Coteron. If it is accepted that the direction of water flow is from south to north it must have been flowing up a gradient. Water responding to an hydraulic head within the phreatic zone often flows uphill.

The possibility of an incomplete or disturbed sediment sequence having been collected and the resulting misrepresentation of results is an obvious concern. The careful selection procedure for the sampling sites was an attempt to minimise such potential problems. A future, more thorough, investigation may vindicate the measures taken here.

Without detailed information with regards to the age of deposits it is not possible to firmly link the morphogenesis of the cave systems investigated. However, with the similarities established between the caves within the four groups, magnetic susceptibility values, visual appearances, altitudes of passage development and hydrological state(active or abandoned), such morphogenic links are probable.

5:7 FURTHER WORK.

(a) WITH THE COLLECTED SAMPLES.

The process of measuring magnetic susceptibility is non destructive. The sediment cores have therefore been retained for possible further analysis. In particular an investigation of the cores' remnant magnetic and or electron spin resonance properties could reveal absolute dates for the deposition of the sediments. The link between cave and surface karst development in Matienzo makes this a very desirable prospect. Such information could allow a chronology to be assigned to the overall geomorphological evolution of the region. The time constraints of this study combined with the lack of facilities to enable remnant magnetic and electron spin resonance decay analysis precluded these options.

Other possible analytical techniques, although resulting in the destruction of the core samples, could be advantageous. Grain size and texture information can indicate source areas, transportation methods and the depositional environment that the sediments have undergone. Bull, Daoxian and Mengyu(1989) have demonstrated this to be the case particularly when scanning electron microscope techniques are employed.

(b) WITHIN THE REGION.

The Matienzo region has considerable potential for further work in the field of karst geomorphology. A more wide ranging study of the type described in this report would further aid the understanding of the geomorphic processes affecting the region.

An analysis of the geochemical configuration of the potential palaeocatchments identified in this study would aid the interpretation of sediments found within the caves of the region. A more detailed sampling programme of sediments from within these areas would also be beneficial. Lack of time prevented a detailed statistical analysis of the grain size distribution data obtained for the sediments collected from the catchment areas but this again could be taken up in any future study.

A considerable quantity of cave survey data is held in digital form by the 'Matienzo Caving Expedition'. Information including passage position, elevation, lengths, inclination and orientation are all available. A statistical analysis of such data coupled with structural geological data could be used to establish the controlling factors acting to shape the cave systems of the area. The construction of a Geographical Information System incorporating this data along with topographic data, present day fluvial systems and sediment types from the region should prove a powerful tool for future studies.

A thorough hydrological study of the region could indicate the source(s) of the various streams found within the caves of Matienzo.

Finally the continued discovery, exploration and surveying of caves in the area is likely to aid the understanding of the karstic evolution of the Matienzo depression, or will it simply pose further questions to be answered?

APPENDIX 1

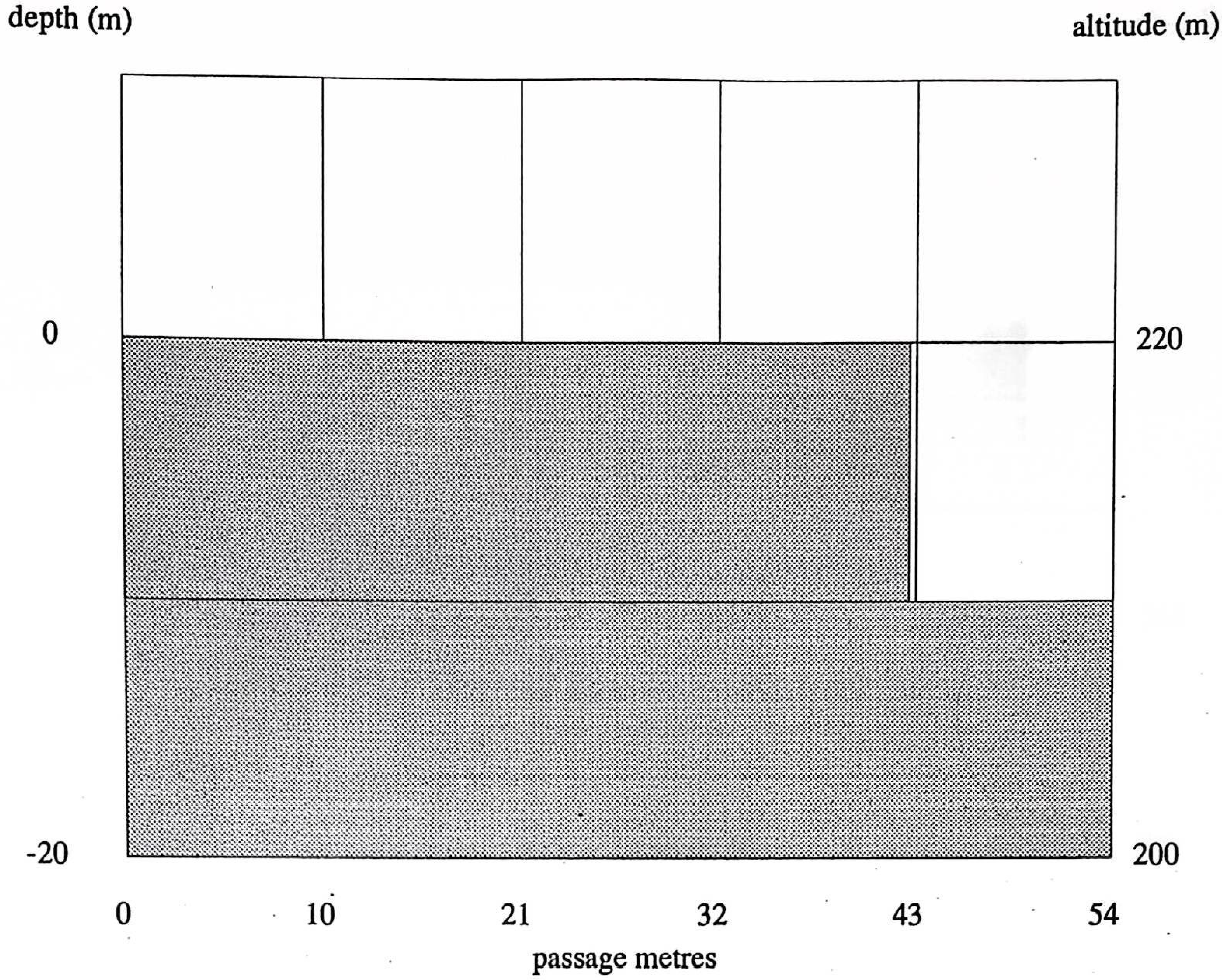
Section 3:9 describes the collecting of samples from all the major levels that occur in the caves to be investigated. The upper level of the South Vega System is one area that should fall into this category. Torca del Azpilicueta has considerable horizontal development at altitudes of around 370m and 250m. It was my intention to collect sediment cores from these sites as part of this study. An incident unconnected with any aspect of this study led to the abandonment of these plans.

It is with considerable regret that I must report the following incident. On the 10th August 1992 a member of the Matienzo Caving Expedition, Mr, Giles Barker, whilst caving with two companions in Torca del Azpilicueta suffered a fall of around 20m. The fall resulted in the instant death of Giles.

APPENDIX 2

PASSAGE ORIENTATION ROSE DIAGRAMS AND LEVELS OF DEVELOPMENT DIAGRAMS FOR THE CAVES SAMPLED.

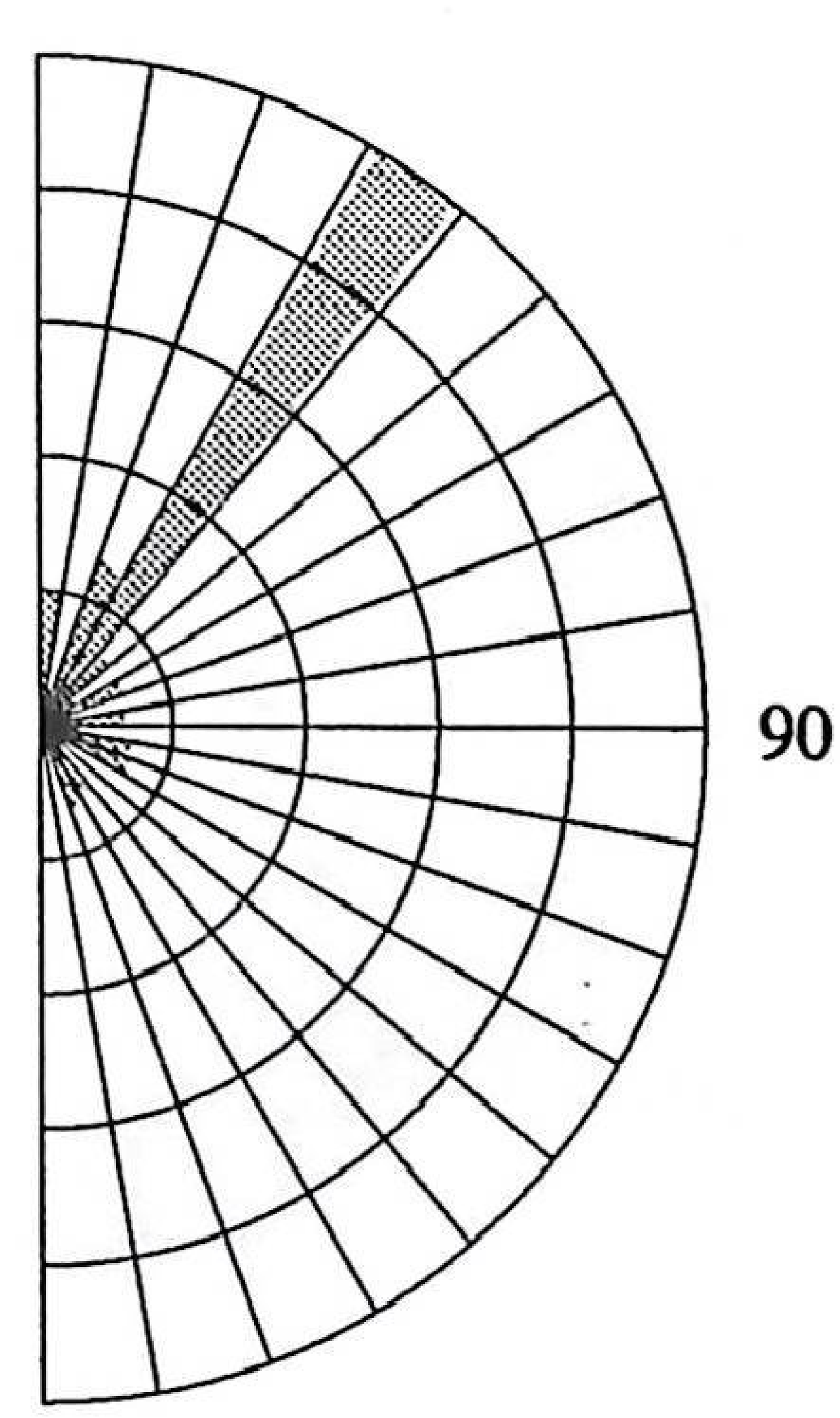
The diagrams on the following pages illustrate the levels of passage development that occur in the caves of Matienzo. Passages are indicated with both their depth from the cave entrance and an elevation above mean sea level. Rose diagrams are also included for the caves that were sampled to highlight passage orientations throughout the individual caves. These diagrams are included in an attempt to convey the character of the caves that were the subject of this study. The diagrams were generated with the aid of an Archimedes computer using survey data collected by the Matienzo Caving Expedition. The assistance of Mr. J Corrin , of the Matienzo Caving Expedition, was invaluable in the production of these diagrams.



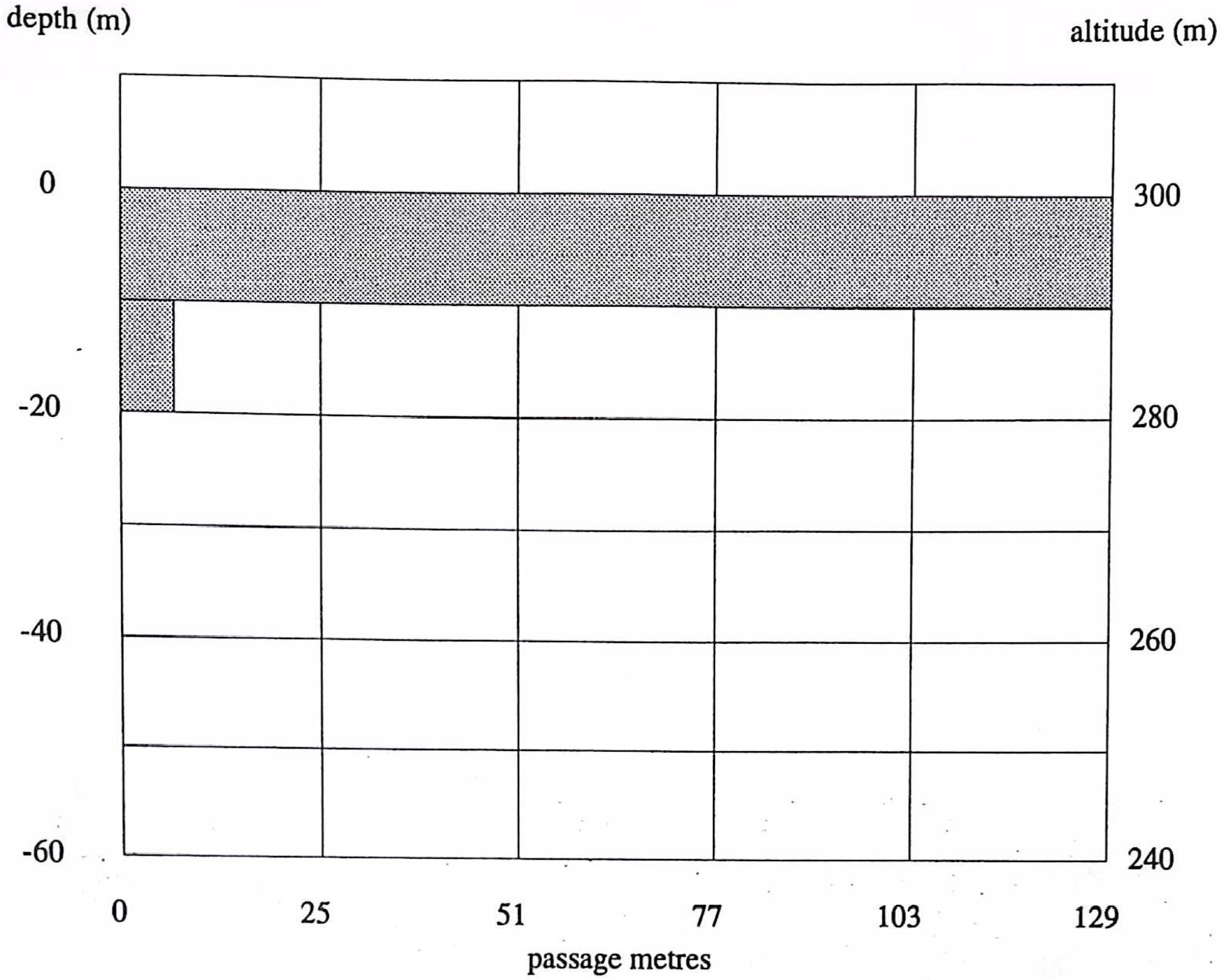
'Levels' of development for Arenal (035)

Plan lengths of passages within ±5° of horizontal

Passage orientation for Arenal
Radius increment: 15m
Longest length is 79m
between angles of 30 - 40°
in a total surveyed plan length of 216m (36%)



Passage orientation and altitudes: Cueva del Arenal

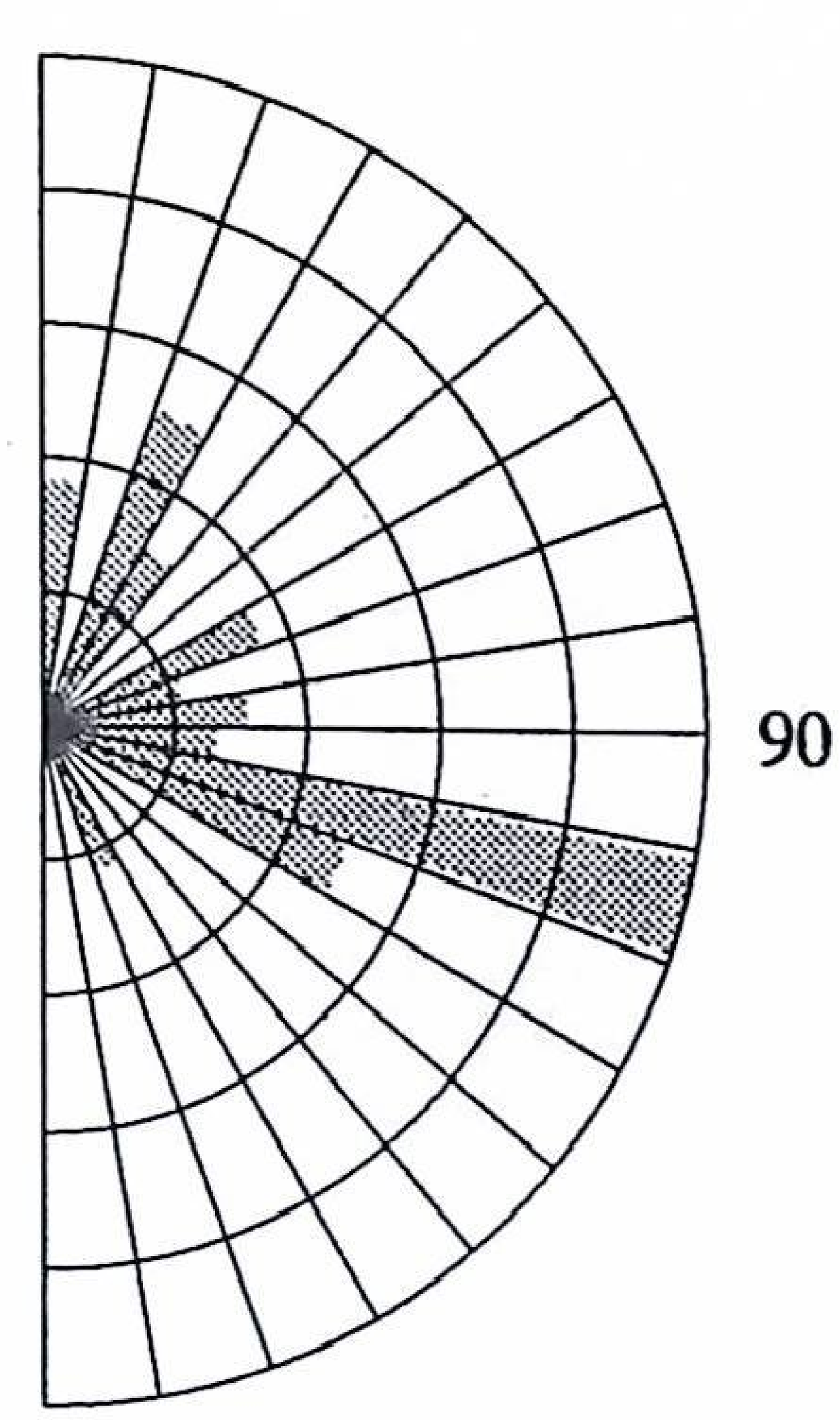


'Levels' of development for Coberruyo (138)

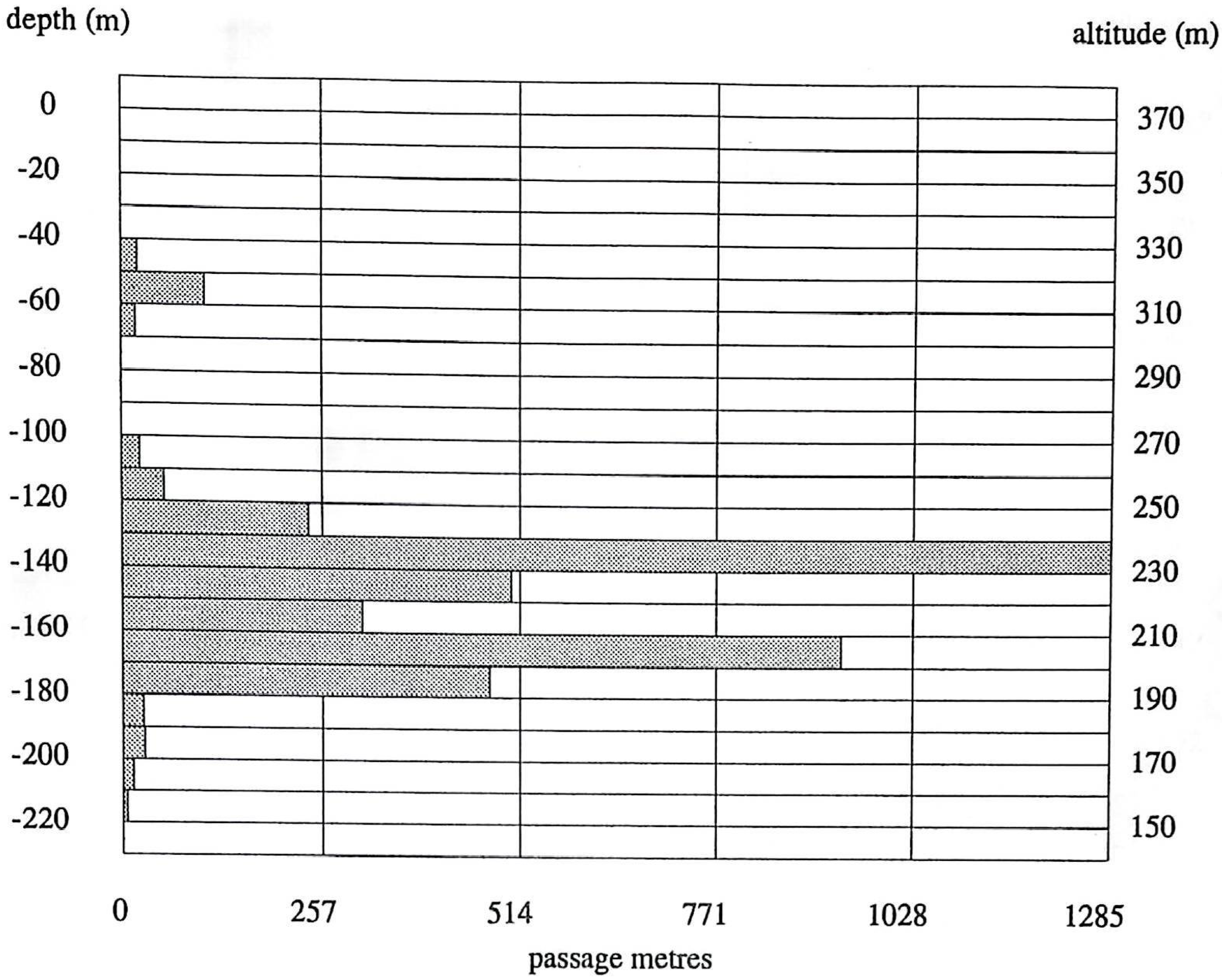
Plan lengths of passages within ±9° of horizontal

60m (from 60m) of unsurveyed passage are included

Passage orientation for Coberruyo
Radius increment: 8m
Longest length is 40m
between angles of 100 - 110°
in a total surveyed plan length of 104m (38%)
60m of unsurveyed passage is also included



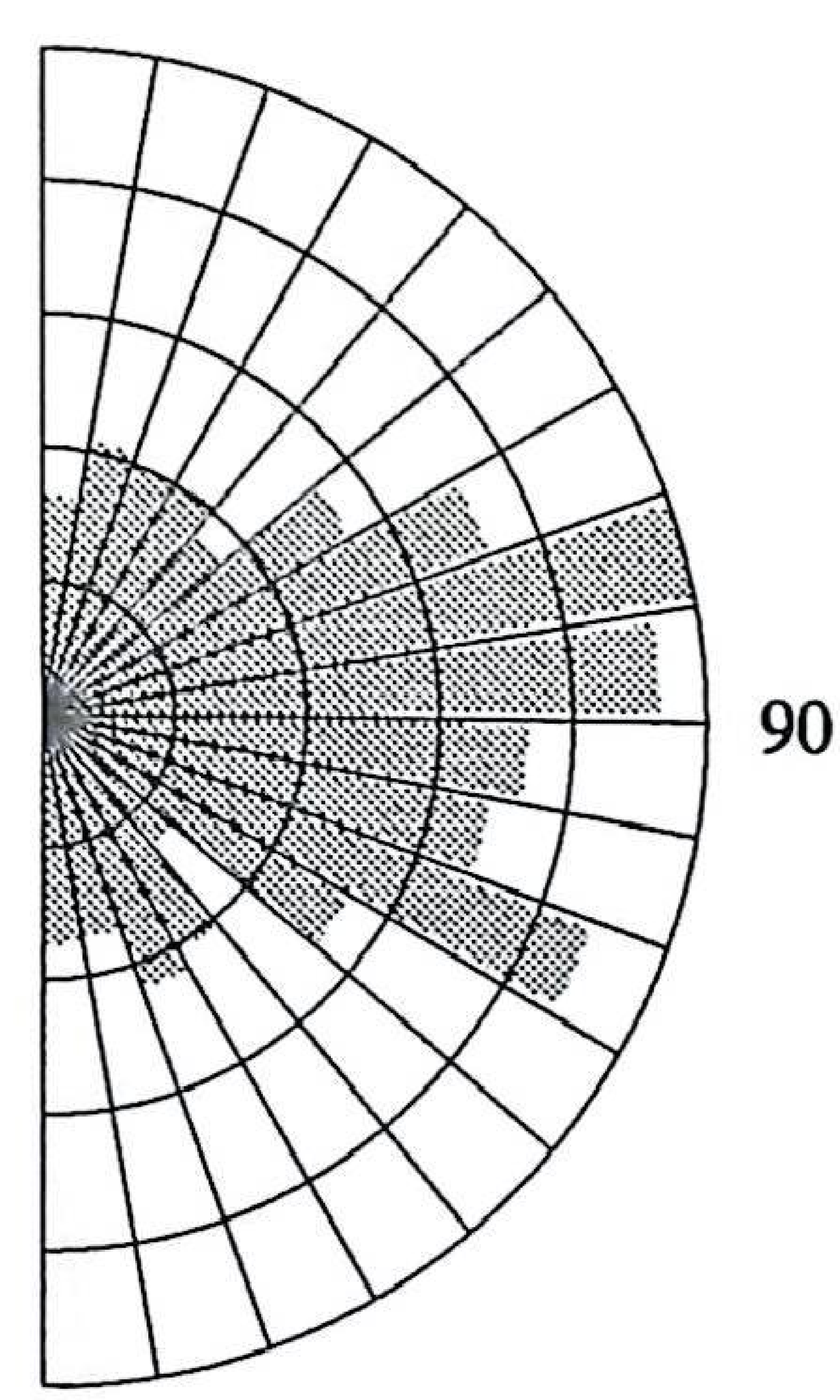
Passage orientation and altitudes: Cueva de Coberruyo



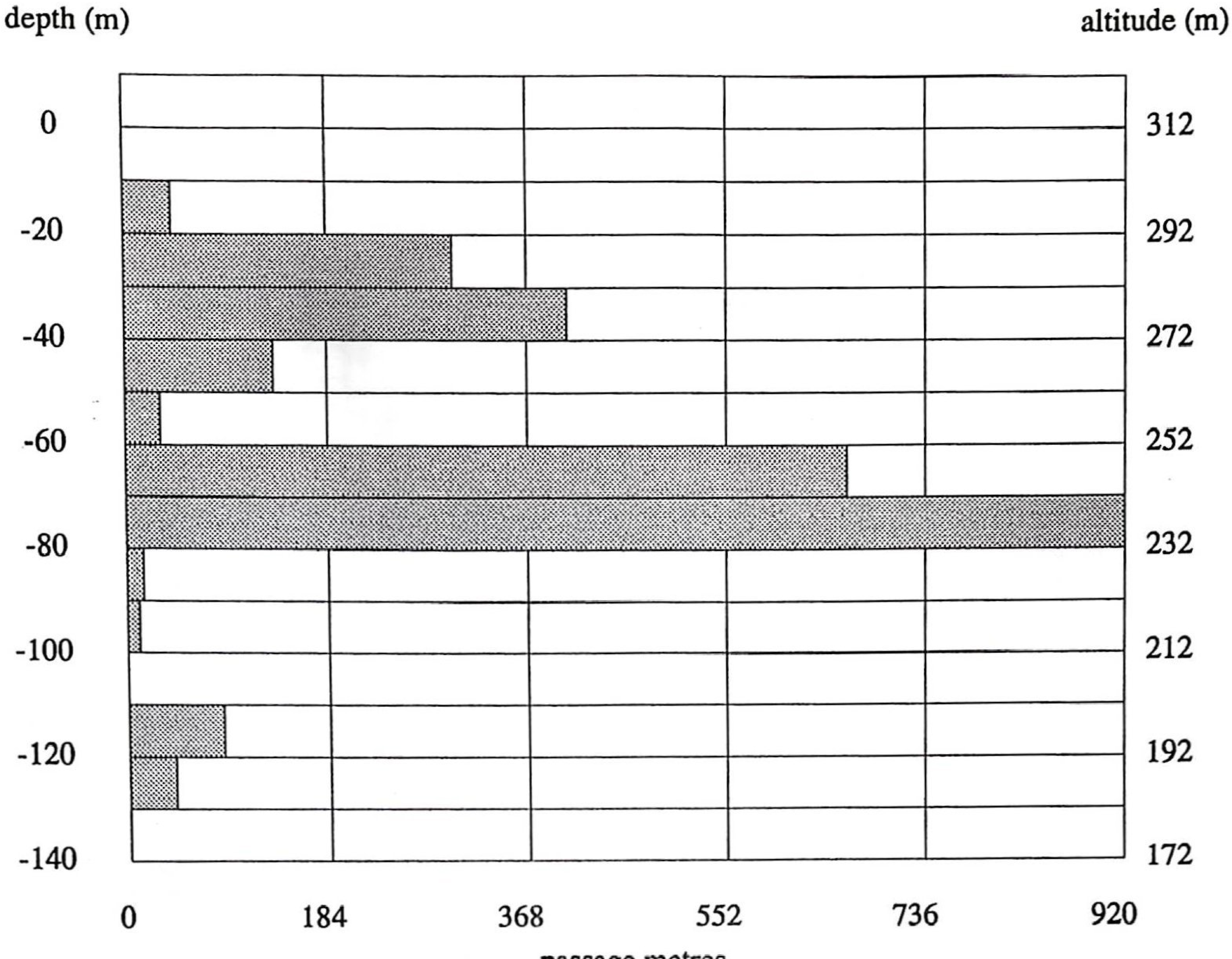
'Levels' of development for Coteron (264)

Plan lengths of passages within ±5° of horizontal

Passage orientation for Coteron
Radius increment: 167m
Longest length is 838m
between angles of 70 - 80°
in a total plan length of 8132m (10%)



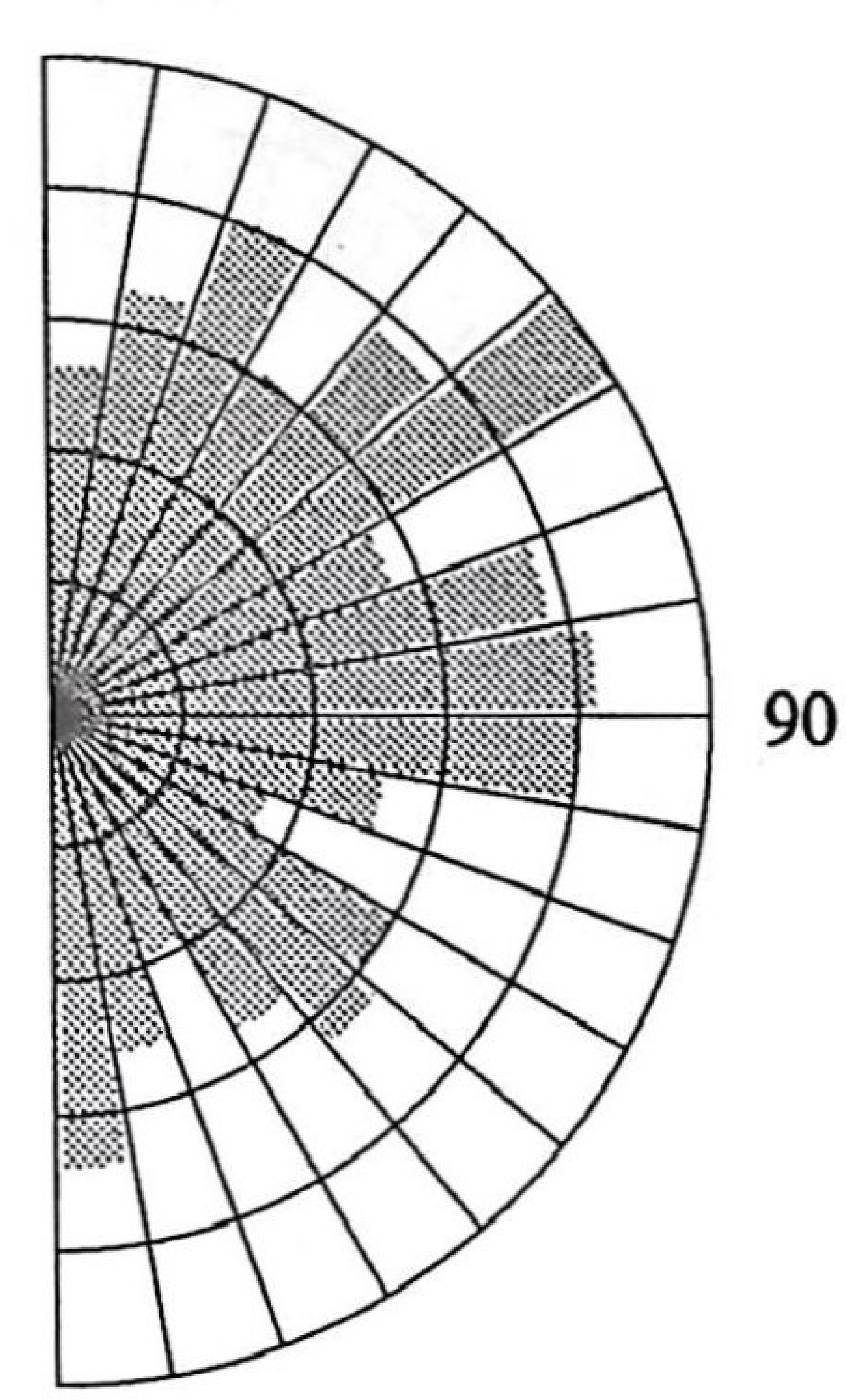
Passage orientation and altitudes: Torca del Coterón



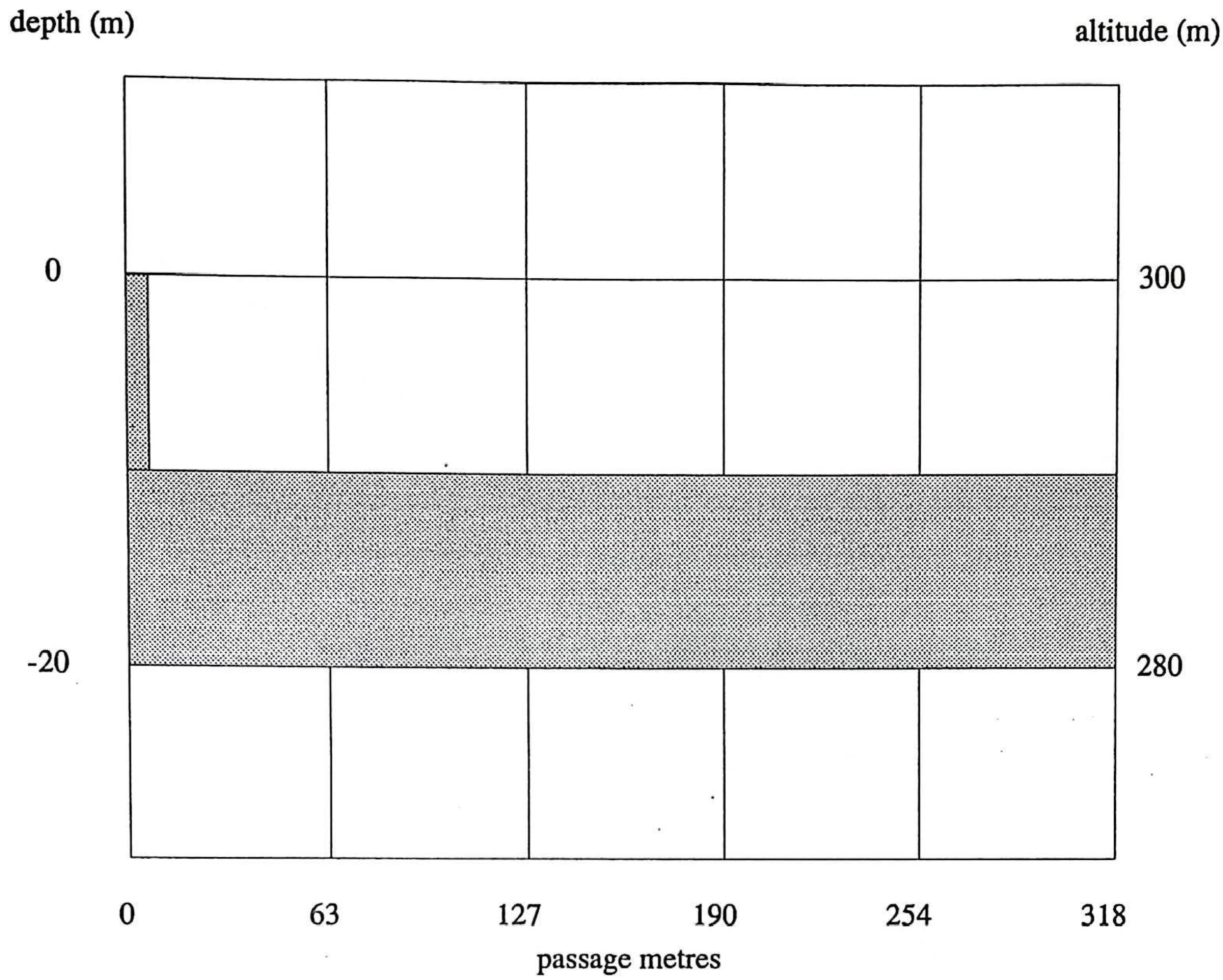
'Levels' of development for Mostajo (71)

Plan lengths of passages within ±5° of horizontal

Passage orientation for Mostajo
Radius increment: 92m
Longest length is 464m
between angles of 50 - 60°
in a total plan length of 5358m (8%)



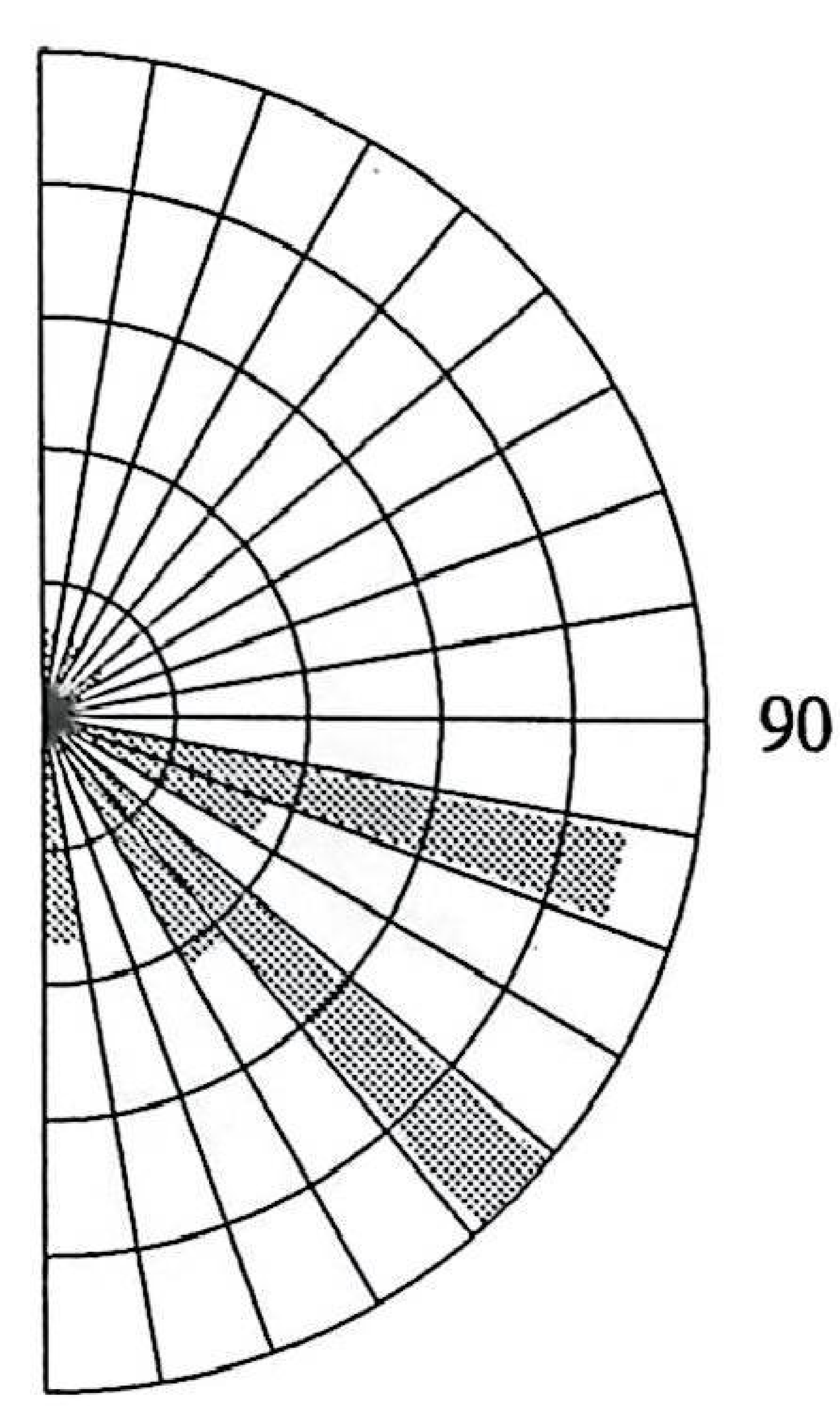
Passage orientation and altitudes: Torca del Mostajo



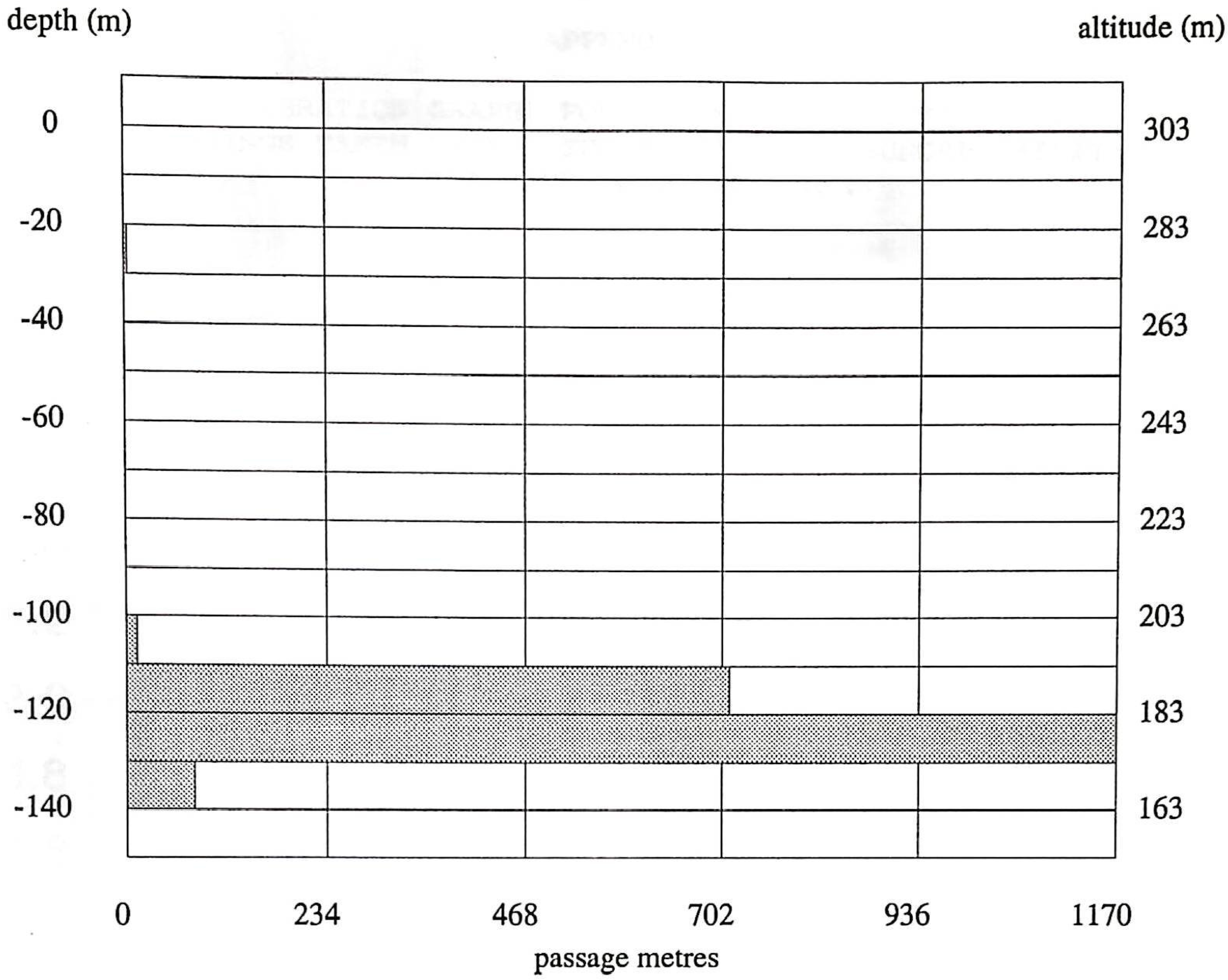
'Levels' of development for Rascavieja (77)

Plan lengths of passages within ±5° of horizontal

Passage orientation for Rascavieja
Radius increment: 29m
Longest length is 148m
between angles of 130 - 140°
in a total plan length of 536m (27%)



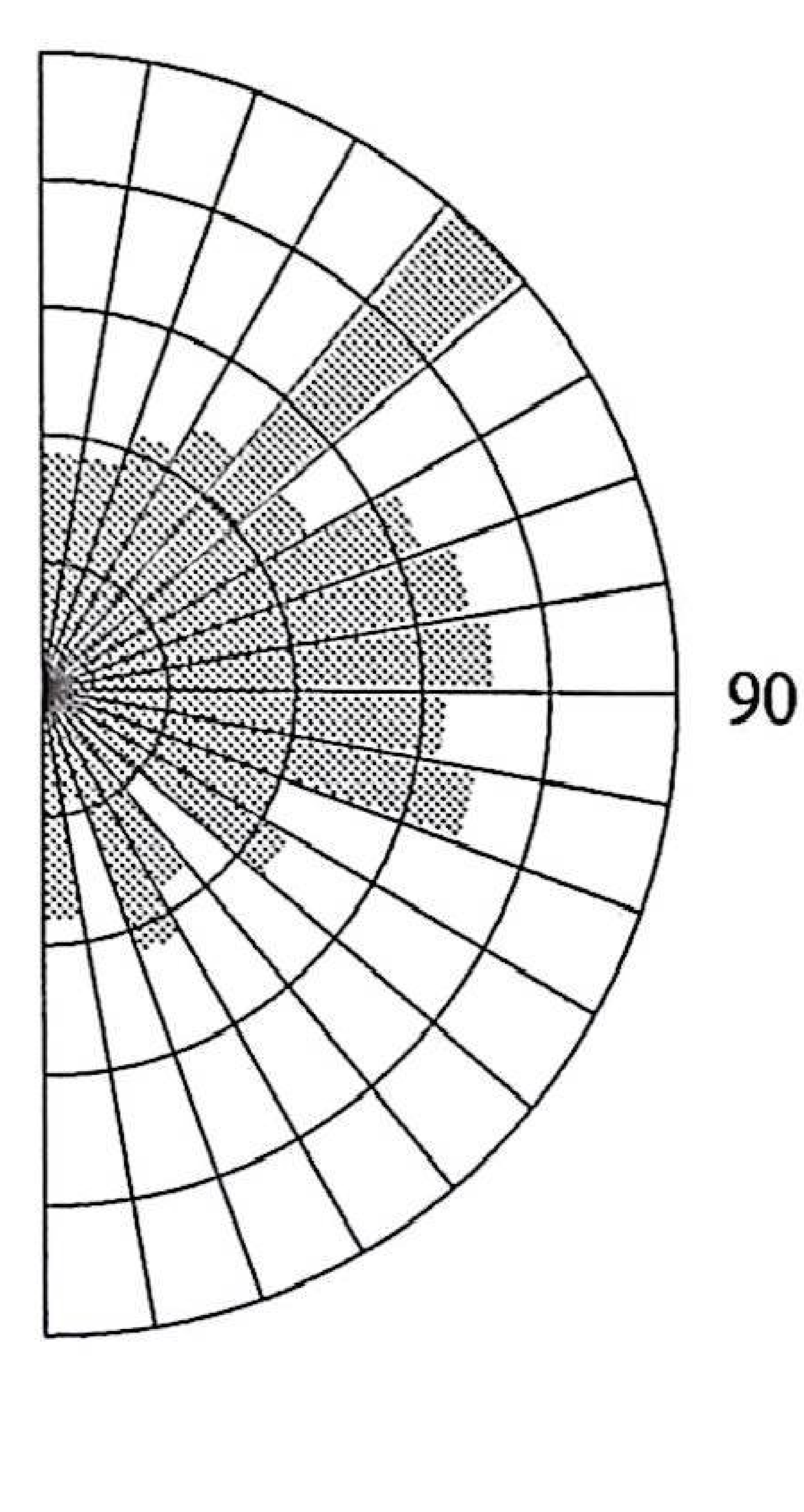
Passage orientation and altitudes: Cueva de Rascavieja



'Levels' of development for Regaton (892)

Plan lengths of passages within ±5° of horizontal

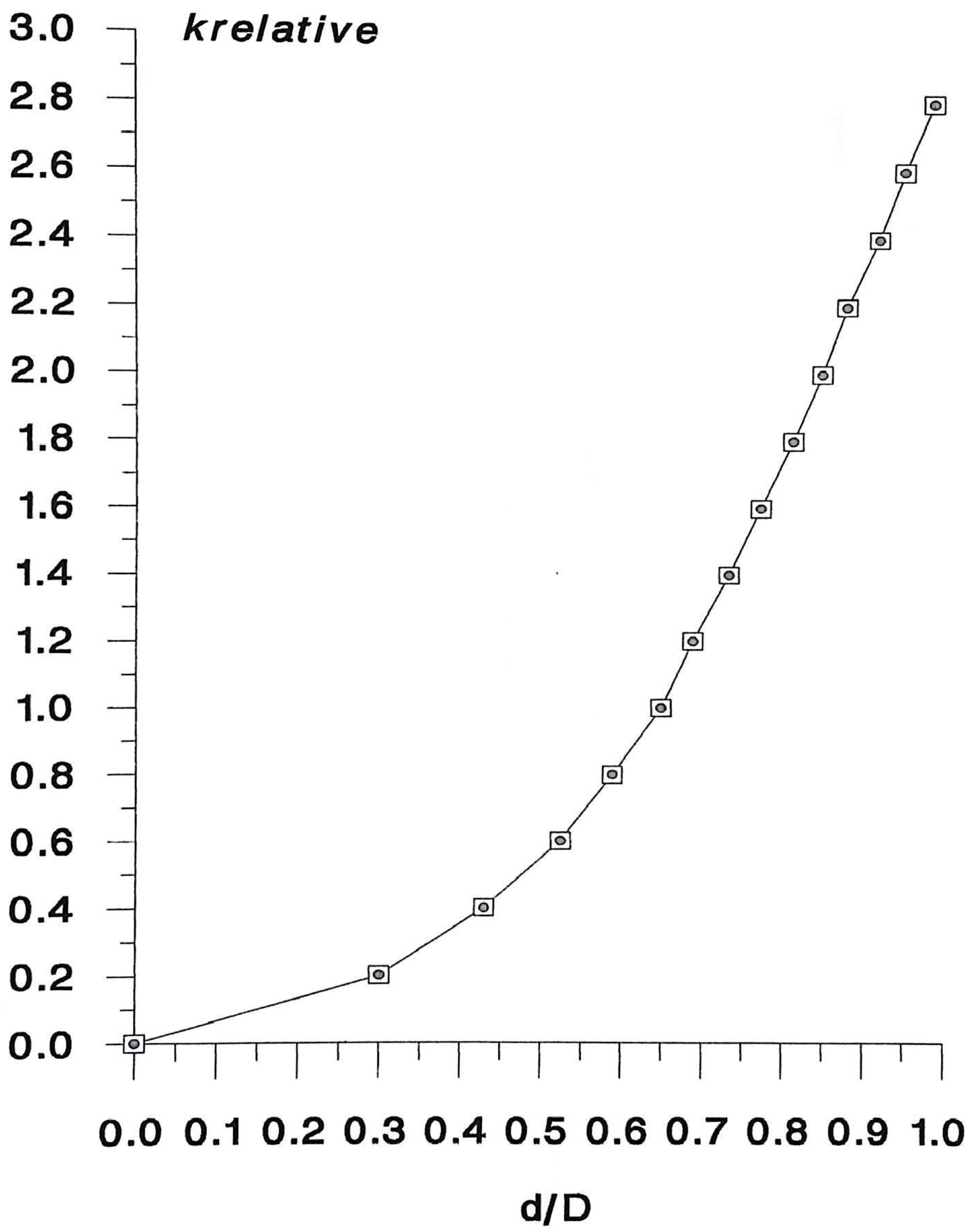
Passage orientation for Regaton
Radius increment: 69m
Longest length is 345m
between angles of 40 - 50°
in a total surveyed plan length of 3067m (11%)



Passage orientation and altitudes: Torca Regaton

APPENDIX 3

CALIBRATION GRAPH FOR MAGNETIC SUSCEPTIBILITY READINGS TAKEN USING THE BARTINGTON SUSCEPTIBILITY METER AND MS2C SENSOR .



Source: Operation Manual For Bartington Magnetic Susceptibility Meter & MS2C Sensor.

APPENDIX 4

DRIFT AND k_{rel} CORRECTIONS AND MAGNETIC SUSCEPTIBILITY VALUES FOR SEDIMENT CORES.

MAGNETIC SUSCEPTIBILITY VALUES.

CORE LENGTH	ARENAL	COBERRUYO	COMELLANTE	COTERON	MOSTAJO 1A	MOSTAJO 2A	MOSTAJO 2B	MOSTAJO 3A	REGATON 1A	REGATON 1B	RASCAVIEJA
0.5	0.2	0.5	0.7	0.1	0.9	0.4	0.2	0.4	0.7	0.4	0.5
1	0.3	0.8	1	0.3	0.8	0.4	0.1	0.7	1	0.6	0.7
1.5	0.4	1	1.1	0.4	0.9	0.5	0.2	0.8	1.2	0.8	0.8
2	0.5	1.3	1.5	0.4	0.9	0.5	0.2	1.1	1.5	0.9	1.1
2.5	0.8	1.5	1.7	0.4	0.9	0.6	0.3	1.2	1.7	1.1	1.3
3	0.6	1.8	2	0.5	0.8	0.5	0.3	1.3	1.9	1.2	1.4
3.5	0.6	2	2.2	0.4	0.8	0.5	0.3	1.5	2.1	1.4	1.6
4	0.6	2.2	2.4	0.5	0.9	0.5	0.3	1.6	2.3	1.5	1.8
4.5	0.7	2.4	2.5	0.5	0.8	0.5	0.4	1.6	2.5	1.6	1.9
5	0.7	2.5	2.7	0.5	0.9	0.5	0.4	1.5	2.6	1.7	2
5.5	0.8	2.5	2.8	0.5	0.8	0.6	0.4	1.5	2.7	1.7	2.1
6	0.7	2.6	3	0.6	0.8	0.6	0.4	1.5	2.9	1.8	2.2
6.5	0.8	2.7	3.1	0.6	0.8	0.7	0.5	1.4	2.9	1.8	2.3
7	0.8	2.7	3.2	0.6	0.8	0.6	0.5	1.4	3	1.8	2.4
7.5	0.8	2.7	3.5	0.6	0.7	0.6	0.5	1.4	3.1	1.9	2.4
8	0.8	2.7	3.7	0.5	0.7	0.7	0.6	1.4	3.2	1.7	2.4
8.5	0.9	2.7	3.9	0.6	0.7	0.7	0.6	1.4	3.4	1.7	2.3
9	0.9	2.7	4.3	0.6	0.7	0.8	0.7	1.3	3.4	1.7	2.4
9.5	1	2.6	4.6	0.6	0.7	0.8	0.7	1.3	3.6	1.8	2.4
10	1.1	2.6	4.9	0.6	0.7	0.7	0.7	1.4	3.6	1.7	2.6
10.5	1.2	2.8	5.3	0.7	0.7	0.8	0.7	1.3	3.7	1.8	2.8
11	1.4	2.6	5.3	0.7	0.8	0.8	0.7	1.3	3.8	1.8	2.8
11.5	1.5	2.4	5.3	0.6	0.7	0.8	0.7	1.3	3.9	1.8	2.9
12	1.9	2.4	5.3	0.7	0.7	0.8	0.7	1.3	4	1.8	3
12.5	2.3	2.2	5.2	0.7	0.7	0.8	0.7	1.4	4	1.8	3.1
13	3	2	5.1	0.7	0.8	0.8	0.6	1.4	4.1	1.8	3.2
13.5	3.9	1.8	5	0.7	0.8	0.9	0.6	1.5	4.1	1.8	3.2
14	4.7	1.6	4.8	0.7	0.9	0.9	0.6	1.4	4.2	1.8	3.2
14.5	6.4	1.6	4.8	0.8	0.9	0.9	0.6	1.6	4.2	1.8	3.3
15	7.6	1.2	4.8	0.8	0.9	0.9	0.7	1.5	4.3	1.9	3.3
15.5	9.2	1.8	4.8	0.7	0.9	0.9	0.6	1.6	4.4	2	3.2
16	10.2	1.8	4.9	0.8	0.9	0.9	0.7	1.6	4.5	2	3.2
16.5	10.9	1.9	5.1	0.8	1	0.9	0.7	1.6	4.6	2.1	3.2
17	11.2	2.1	5.3	0.7	1	0.9	0.6	1.6	4.6	2.1	3.2
17.5	10.9	2.2	5.8	0.8	1	0.9	0.6	1.6	4.6	2.3	3.2
18	10.4	2.4	6	0.8	1	0.9	0.6	1.6	4.5	2.4	3.2
18.5	9.7	2.5	6.5	0.8	1.1	0.9	0.6	1.6	4.5	2.6	3.3
19	9.2	2.6	7	0.8	1.1	0.9	0.7	1.6	4.5	2.8	3.2
19.5	8.8	2.7	7.5	0.8	1.2	1	0.6	1.6	4.4	2.9	3.2
20	8.5	2.7	7.9	0.8	1.2	0.9	0.6	1.6	4.3	3.3	3.2
20.5	8.5	2.6	8	0.9	1.2	1	0.7	1.8	4.2	3.7	3.1
21	8.4	2.6	7.7	0.9	1.2	1	0.6	1.8	4.2	4.1	3
21.5	8.3	2.6	7.1	0.9	1.3	1	0.7	1.6	4.1	4.7	2.8
22	7.7	2.6	6.5	0.9	1.4	1	0.7	1.6	4.1	5.4	2.5
22.5	7.1	2.5	5.8	0.8	1.4	1	0.7	1.8	4.2	6.2	2.4
23	6.2	2.4	5.1	0.7	1.4	1	0.7	1.5	4.3	7	2.2
23.5	5.2	2.3	4.7	0.8	1.5	0.9	0.7	1.5	4.5	8.1	2.1
24	4.4	2.3	4.3	0.8	1.4	0.9	0.6	1.6	4.9	8.8	2
24.5	3.5	2.2	3.9	0.8	1.5	1	0.7	1.5	5.3	10.1	1.9
25	3.1	2.2	3.7	0.8	1.5	1	0.7	1.5	5.8	11.1	1.9
25.5	2.8	2.1	3.5	0.7	1.5	1	0.6	1.5	6.5	13.1	1.9
26	2.2	2	3.3	0.7	1.5	1	0.7	1.5	7.6	14.7	2
26.5	1.9	2	3.2	0.8	1.5	1.1	0.7	1.4	8.7	16.6	2
27	1.8	2	3	0.7	1.5	1.1	0.7	1.5	10.1	18.5	2.1
27.5	1.7	2	2.9	0.7	1.5	1.1	0.7	1.5	11.4	20.1	2
28	1.6	2	2.8	0.7	1.4	1	0.7	1.5	12.3	21.6	2.1
28.5	1.5	2.1	2.7	0.6	1.4	1	0.7	1.6	13.6	22.8	2
29	1.5	2.2	2.7	0.6	1.4	1.1	0.7	1.5	14.4	23.7	1.7
29.5	1.5	2.3	2.6	0.7	1.4	1.1	0.6	1.6	14.5	24.3	1.6
30	1.4	2.4	2.5	0.6	1.3	1.1	0.6	1.6	14.2	24.2	1.3
30.5	1.4	2.5	2.5	0.6	1.3	1.1	0.6	1.6	13.5	23.6	1.1
31	1.4	2.5	2.4	0.7	1.3	1	0.5	1.6	12.5	22.7	0.8
31.5	1.4	2.6	2.4	0.8	1.3	1	0.5	1.5	11.5	21.5	0.6
32	1.4	2.7	2.3	0.8	1.2	1.1	0.5	1.4	10.5	20.5	0.4
32.5	1.4	2.7	2.3	0.8	1.3	1	0.5	1.4	9.5	19.8	0.2
33	1.3	2.7	2.2	0.8	1.2	1	0.4	1.4	8.7	19.1	0
33.5	1.4	2.7	2.1	0.9	1.2	1	0.4	1.3	8.2	19	0
34	1.3	2.7	1.9	0.9	1.1	1.1	0.4	1.3	7.8	19.2	0
34.5	1.3	2.7	1.8	0.9	1.1	1	0.5	1.2	7.6	19.8	0
35	1.2	2.6	1.7	1	0.9	1	0.4	1.2	7.9	20.5	0
35.5	1.1	2.6	1.6	1.1	0.8	0.9	0.4	1.2	8.3	21.2	0
36	1	2.6	1.5	1.1	0.8	0.9	0.4	1.2	8.9	21.9	0
36.5	0.8	2.5	1.5	1.2	0.6	0.9	0.5	1.1	9.8	22.7	0
37	0.7	2.4	1.5	1.2	0.5	0.9	0.4	1.1	10.7	23.4	0
37.5	0.5	2.4	1.5	1.3	0.4	0.8	0.4	1	11.6	24.2	0
38	0.4	2.3	1.5	1.3	0.3	0.8	0.5	1	12.3	26.2	0
38.5	0	2.2	1.5	1.4	0.2	0.8	0.5	1	12.8	28.3	0
39	0	2.2	1.4	1.5	0	0.7	0.5	1	13	27.8	0
39.5	0	2.2	1.3	1.5	0	0.7	0.6	1	12.9	29.1	0
40	0	2.2	1.4	1.6	0	0.7	0.6	1	12.5	31.2	0
40.5	0	2.2	1.3	1.7	0	0.7	0.6	0.9	12	33.7	0
41	0	2.1	1.2	1.7	0	0.7	0.6	1	11.1	36.2	0
41.5	0	2.2	1.1	1.7	0	0.7	0.5	0.9	10.3	38.6	0
42	0	2.1	0.9	1.8	0	0.7	0.5	0.9	9.1	40.1	0
42.5	0	2.2	0.8	1.7	0	0.8	0.5	0.9	8.7	41.1	0
43	0	2.2	0.7	1.6	0	0.8	0.4	0.9	7.7	41.2	0
43.5	0	2.1	0.5	1.6	0	0.8	0.4	0.9	6.8	40.5	0
44	0	2	0.4	1.5	0	0.9	0.5	0.8	6.3	39	0
44.5	0	2	0.4	1.5	0	0.9	0.5	0.9	5.6	37.3	0
45	0	1.9	0	1.4	0	0.9	0.5	1	5.2	35.3	0
45.5	0	1.9	0	1.4	0	0.9	0.3	1	4.9	32.2	0
46	0	1.9	0	1.4	0	0.9	0.4	1	4.8	29.4	0
46.5	0	1.9	0	1.4	0	0.9	0.3	1	4.7	27.3	0
47	0	1.9	0	1.4	0	0.9	0.4	1	4.7	25.1	0
47.5	0	2	0	1.4	0	0.9	0.4	1	4.6	23.8	0
48	0	2.1	0	1.3	0	0.9	0.4	1.1	4.7	22.9	0
48.5	0	2.2	0	1.3	0	0.9	0.5	1.1	4.6	22.5	0
49	0	2.2	0	1.1	0	0.9	0.4	1.1	4.6	22.5	0
49.5	0	2.3	0	1.1	0	0.9	0.5	1.1	4.5	22.7	0
50	0	2.5	0	1.1	0	0.8	0.6	1.1	4.5	22.8	0
50.5	0	2.6	0	1	0	0.8	0.7	1.1	4.3	22.3	0
51	0	2.7	0	0.7	0	0.8	0.8	1.1	4.1	21.3	0
51.5	0	3	0	0.6	0	0.7	0.8	1	4	19.8	0
52	0	3.2	0	0.5	0	0.7	0.8	1.1	3.8	17.3	0
52.5	0	3.4	0	0.3	0	0.7	0.9	1	3.6	14.8	0
53	0	3.7	0	0.2	0	0.7	0.8	1	3.4	12.2	0
53.5	0	3.9	0	0	0	0.7	0.8	1.1	3.2	9.9	0

MAGNETIC SUSCEPTIBILITY VALUES

54	0	3.8	0	0	0	0.6	0.7	1	3.1	7.8	0
54.5	0	3.7	0	0	0	0.6	0.7	1	3	5.5	0
55	0	3.2	0	0	0	0.5	0.6	1	2.8	4.1	0
55.5	0	2.7	0	0	0	0.6	0.6	1	2.8	3	0
56	0	2.1	0	0	0	0.6	0.5	0.9	2.8	2.2	0
56.5	0	1.6	0	0	0	0.6	0.5	0.9	2.7	0	0
57	0	1.3	0	0	0	0.6	0.4	1	2.8	0	0
57.5	0	0.9	0	0	0	0.6	0.4	0.9	2.7	0	0
58	0	0.7	0	0	0	0.6	0.4	0.9	2.8	0	0
58.5	0	0	0	0	0	0.5	0.4	0.9	2.8	0	0
59	0	0	0	0	0	0.6	0.4	0.9	2.9	0	0
59.5	0	0	0	0	0	0.6	0.4	0.8	3	0	0
60	0	0	0	0	0	0.6	0.4	0.8	3.1	0	0
60.5	0	0	0	0	0	0.6	0.4	0.8	3.2	0	0
61	0	0	0	0	0	0.6	0.4	0.7	3.2	0	0
61.5	0	0	0	0	0	0.6	0.4	0.7	3.4	0	0
62	0	0	0	0	0	0.6	0.4	0.7	3.5	0	0
62.5	0	0	0	0	0	0.6	0.4	0.6	3.6	0	0
63	0	0	0	0	0	0.6	0.4	0.6	3.7	0	0
63.5	0	0	0	0	0	0.6	0.4	0.6	3.7	0	0
64	0	0	0	0	0	0.6	0.3	0.5	3.8	0	0
64.5	0	0	0	0	0	0.5	0.3	0.4	3.8	0	0
65	0	0	0	0	0	0.5	0.2	0.4	3.6	0	0
65.5	0	0	0	0	0	0.5	0.2	0.3	3.4	0	0
66	0	0	0	0	0	0.6	0.2	0.3	3.1	0	0
66.5	0	0	0	0	0	0.5	0.2	0.2	3	0	0
67	0	0	0	0	0	0.6	0.2	0.1	2.8	0	0
67.5	0	0	0	0	0	0.6	0.1	0.2	2.5	0	0
68	0	0	0	0	0	0.6	0.1	0	2.5	0	0
68.5	0	0	0	0	0	0.6	0.1	0	2.3	0	0
69	0	0	0	0	0	0.6	0.1	0	2.3	0	0
69.5	0	0	0	0	0	0.5	0	0	2.3	0	0
70	0	0	0	0	0	0.5	0	0	2.2	0	0
70.5	0	0	0	0	0	0.6	0	0	2.2	0	0
71	0	0	0	0	0	0.6	0	0	2.2	0	0
71.5	0	0	0	0	0	0.6	0	0	2.3	0	0
72	0	0	0	0	0	0.6	0	0	2.3	0	0
72.5	0	0	0	0	0	0.6	0	0	2.4	0	0
73	0	0	0	0	0	0.6	0	0	2.4	0	0
73.5	0	0	0	0	0	0.6	0	0	2.5	0	0
74	0	0	0	0	0	0.6	0	0	2.6	0	0
74.5	0	0	0	0	0	0.6	0	0	2.6	0	0
75	0	0	0	0	0	0.6	0	0	2.6	0	0
75.5	0	0	0	0	0	0.7	0	0	2.7	0	0
76	0	0	0	0	0	0.7	0	0	2.8	0	0
76.5	0	0	0	0	0	0.6	0	0	2.9	0	0
77	0	0	0	0	0	0.6	0	0	2.9	0	0
77.5	0	0	0	0	0	0.6	0	0	3	0	0
78	0	0	0	0	0	0.6	0	0	3.1	0	0
78.5	0	0	0	0	0	0.6	0	0	3.1	0	0
79	0	0	0	0	0	0.6	0	0	3.1	0	0
79.5	0	0	0	0	0	0.6	0	0	3.1	0	0
80	0	0	0	0	0	0.6	0	0	3	0	0
80.5	0	0	0	0	0	0.6	0	0	2.9	0	0
81	0	0	0	0	0	0.6	0	0	2.7	0	0
81.5	0	0	0	0	0	0.6	0	0	2.6	0	0
82	0	0	0	0	0	0.6	0	0	2.3	0	0
82.5	0	0	0	0	0	0.6	0	0	2	0	0
83	0	0	0	0	0	0.7	0	0	1.7	0	0
83.5	0	0	0	0	0	0.7	0	0	1.4	0	0
84	0	0	0	0	0	0.5	0	0	1.1	0	0
84.5	0	0	0	0	0	0.5	0	0	0.9	0	0
85	0	0	0	0	0	0.5	0	0	0.7	0	0
85.5	0	0	0	0	0	0.4	0	0	0	0	0
86	0	0	0	0	0	0.4	0	0	0	0	0
86.5	0	0	0	0	0	0.4	0	0	0	0	0
87	0	0	0	0	0	0.4	0	0	0	0	0
87.5	0	0	0	0	0	0.3	0	0	0	0	0
88	0	0	0	0	0	0.2	0	0	0	0	0
88.5	0	0	0	0	0	0.2	0	0	0	0	0
89	0	0	0	0	0	0.2	0	0	0	0	0

CORRECTIONS TO SAMPLE READINGS

ARENAL

Rm	DRIFT	0.48*(Rm-DRIFT)	k
0.9	0.4	0.24	0.2
1	0.4092	0.283584	0.3
1.2	0.4184	0.375168	0.4
1.4	0.4276	0.466752	0.5
1.6	0.4368	0.558336	0.6
1.6	0.446	0.55392	0.6
1.8	0.4552	0.645504	0.6
1.8	0.4644	0.641088	0.6
1.9	0.4736	0.684672	0.7
2	0.4828	0.728256	0.7
2.1	0.492	0.77184	0.8
2	0.5012	0.719424	0.7
2.1	0.5104	0.763008	0.8
2.1	0.5196	0.758592	0.8
2.2	0.5288	0.802176	0.8
2.2	0.538	0.79776	0.8
2.4	0.5472	0.889344	0.9
2.5	0.5564	0.932928	0.9
2.7	0.5656	1.024512	1.0
2.8	0.5748	1.068096	1.1
3	0.584	1.15968	1.2
3.5	0.5932	1.395264	1.4
3.8	0.6024	1.534848	1.5
4.5	0.6116	1.866432	1.9
5.5	0.6208	2.342016	2.3
6.8	0.63	2.9616	3.0
8.8	0.6392	3.917184	3.9
10.5	0.6484	4.728768	4.7
14	0.6576	6.404352	6.4
16.5	0.6668	7.599936	7.6
19.8	0.676	9.17952	9.2
21.9	0.6852	10.183104	10.2
23.4	0.6944	10.898688	10.9
24	0.7036	11.182272	11.2
23.5	0.7128	10.937856	10.9
22.3	0.722	10.35744	10.4
21	0.7312	9.729024	9.7
19.9	0.7404	9.196608	9.2
19	0.7496	8.760192	8.8
18.5	0.7588	8.515776	8.5
18.4	0.768	8.46336	8.5
18.2	0.7772	8.362944	8.4
18	0.7864	8.262528	8.3
16.8	0.7956	7.682112	7.7
15.5	0.8048	7.053696	7.1
13.7	0.814	6.18528	6.2
11.7	0.8232	5.220864	5.2
9.9	0.8324	4.352448	4.4
8.2	0.8416	3.532032	3.5
7.3	0.8508	3.095616	3.1
6.3	0.86	2.6112	2.6
5.5	0.8692	2.222784	2.2
4.9	0.8784	1.930368	1.9
4.7	0.8876	1.829952	1.8
4.5	0.8968	1.729536	1.7
4.3	0.906	1.62912	1.6
4.1	0.9152	1.528704	1.5
4	0.9244	1.476288	1.5
4	0.9336	1.471872	1.5
3.8	0.9428	1.371456	1.4
3.8	0.952	1.36704	1.4
3.8	0.9612	1.362624	1.4
3.8	0.9704	1.358208	1.4
3.8	0.9796	1.353792	1.4
3.9	0.9888	1.397376	1.4
3.8	0.998	1.34496	1.3
3.9	1.0072	1.388544	1.4
3.8	1.0164	1.336128	1.3
3.8	1.0256	1.331712	1.3
3.6	1.0348	1.231296	1.2
3.4	1.044	1.13088	1.1
3.1	1.0532	0.982464	1.0
2.7	1.0624	0.786048	0.8
2.5	1.0716	0.685632	0.7
2.2	1.0808	0.537216	0.5
1.9	1.09	0.3888	0.4

COBERRUY

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.2	0.4	0.384	0.4
1.4	0.40427	0.4779504	0.5
2	0.40854	0.7639008	0.8
2.6	0.41281	1.0498512	1.0
3.1	0.41708	1.2878016	1.3
3.6	0.42135	1.525752	1.5
4.2	0.42562	1.8117024	1.8
4.6	0.42989	2.0016528	2.0
5	0.43416	2.1916032	2.2
5.4	0.43843	2.3815536	2.4
5.6	0.4427	2.475504	2.5
5.7	0.44697	2.5214544	2.5
5.9	0.45124	2.6154048	2.6
6	0.45551	2.6613552	2.7
6.1	0.45978	2.7073056	2.7
6.1	0.46405	2.705256	2.7
6.1	0.46832	2.7032064	2.7
6	0.47259	2.6531568	2.7
6	0.47686	2.6511072	2.7
6	0.48113	2.6490576	2.6
6	0.4854	2.647008	2.6
5.9	0.48967	2.5969584	2.6
5.7	0.49394	2.4989088	2.5
5.6	0.49821	2.4488592	2.4
5.4	0.50248	2.3508096	2.4
5	0.50675	2.15676	2.2
4.7	0.51102	2.0107104	2.0
4.2	0.51529	1.7686608	1.8
3.9	0.51956	1.6226112	1.6
3.8	0.52383	1.5725616	1.6
3	0.5281	1.186512	1.2
3.9	0.53237	1.6164624	1.6
4.2	0.53664	1.7584128	1.8
4.5	0.54091	1.9003632	1.9
4.9	0.54518	2.0903136	2.1
5.1	0.54945	2.184264	2.2
5.6	0.55372	2.4222144	2.4
5.8	0.55799	2.5161648	2.5
6	0.56226	2.6101152	2.6
6.1	0.56653	2.6560656	2.7
6.1	0.5708	2.654016	2.7
6	0.57507	2.6039664	2.6
6	0.57934	2.6019168	2.6
6	0.58361	2.5998672	2.6
5.8	0.58788	2.5018176	2.5
5.7	0.59215	2.451768	2.5
5.5	0.59642	2.3537184	2.4
5.4	0.60069	2.3036688	2.3
5.3	0.60496	2.2536192	2.3
5.2	0.60923	2.2035696	2.2
5.1	0.6135	2.15352	2.2
4.9	0.61777	2.0554704	2.1
4.8	0.62204	2.0054208	2.0
4.7	0.62631	1.9553712	2.0
4.7	0.63058	1.9533216	2.0
4.7	0.63485	1.951272	2.0
4.8	0.63912	1.9972224	2.0
5	0.64339	2.0911728	2.1
5.3	0.64766	2.2331232	2.2
5.4	0.65193	2.2790736	2.3
5.7	0.6562	2.421024	2.4
5.8	0.66047	2.4669744	2.5
5.9	0.66474	2.5129248	2.5
6	0.66901	2.5588752	2.6
6.2	0.67328	2.6528256	2.7
6.3	0.67755	2.698776	2.7
6.4	0.68182	2.7447264	2.7
6.4	0.68609	2.7426768	2.7
6.4	0.69036	2.7406272	2.7
6.3	0.69463	2.6905776	2.7
6.2	0.6989	2.640528	2.6
6.2	0.70317	2.6384784	2.6
6.1	0.70744	2.5884288	2.6
5.9	0.71171	2.4903792	2.5
5.8	0.71598	2.4403296	2.4
5.7	0.72025	2.39028	2.4
5.6	0.72452	2.3402304	2.3
5.4	0.72879	2.2421808	2.2
5.4	0.73306	2.2401312	2.2
5.3	0.73733	2.1900816	2.2
5.3	0.7416	2.188032	2.2
5.3	0.74587	2.1859824	2.2
5.2	0.75014	2.1359328	2.1
5.3	0.75441	2.1818832	2.2
5.2	0.75868	2.1318336	2.1
5.3	0.76295	2.177784	2.2
5.3	0.76722	2.1757344	2.2
5.1	0.77149	2.0776848	2.1
5	0.77576	2.0276352	2.0
4.9	0.78003	1.9775856	2.0
4.8	0.7843	1.927536	1.9
4.8	0.78857	1.9254864	1.9
4.7	0.79284	1.8754368	1.9
4.7	0.79711	1.8733872	1.9
4.8	0.80138	1.9193376	1.9
4.9	0.80565	1.965288	2.0
5.2	0.80992	2.1072384	2.1
5.3	0.81419	2.1531888	2.2
5.5	0.81846	2.2471392	2.2
5.7	0.82273	2.3410896	2.3
6	0.827	2.48304	2.5
6.2	0.83127	2.5769904	2.6
6.5	0.83554	2.7189408	2.7
7	0.83981	2.9568912	3.0
7.6	0.84408	3.2428416	3.2
8	0.84835	3.432792	3.4
8.5	0.85262	3.6707424	3.7
8.9	0.85689	3.8606928	3.9
8.8	0.86116	3.8106432	3.8
8.5	0.86543	3.6645936	3.7
7.6	0.8697	3.230544	3.2
6.4	0.87397	2.6524944	2.7
5.3	0.87824	2.1224448	2.1
4.3	0.88251	1.6403952	1.6
3.5	0.88678	1.2543456	1.3
2.7	0.89105	0.868296	0.9
2.3	0.89532	0.6742464	0.7

COMELLAN

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.6	0.4	0.576	0.6
1.9	0.40778	0.7162656	0.7
2.4	0.41556	0.9525312	1.0
2.8	0.42334	1.1407968	1.1
3.5	0.43112	1.4730624	1.5
4	0.4389	1.709328	1.7
4.6	0.44668	1.9935936	2.0
5	0.45446	2.1818592	2.2
5.4	0.46224	2.3701248	2.4
5.7	0.47002	2.5103904	2.5
6.1	0.4778	2.698656	2.7
6.4	0.48558	2.8389216	2.8
6.7	0.49336	2.9791872	3.0
6.9	0.50114	3.0714528	3.1
7.2	0.50892	3.2117184	3.2
7.8	0.5167	3.495984	3.5
8.3	0.52448	3.7322496	3.7
8.7	0.53226	3.9205152	3.9
9.4	0.54004	4.2527808	4.3
10.1	0.54782	4.5850464	4.6
10.7	0.5556	4.869312	4.9
11.7	0.56338	5.3455776	5.3
11.6	0.57116	5.2938432	5.3
11.6	0.57894	5.2901088	5.3
11.7	0.58672	5.3343744	5.3
11.4	0.5945	5.18664	5.2
11.2	0.60228	5.0869056	5.1
11	0.61006	4.9871712	5.0
10.7	0.61784	4.8394368	4.8
10.6	0.62562	4.7877024	4.8
10.6	0.6334	4.783968	4.8
10.6	0.64118	4.7802336	4.8
10.8	0.64896	4.8724992	4.9
11.2	0.65674	5.0607648	5.1
11.8	0.66452	5.3450304	5.3
12.3	0.6723	5.581296	5.6
13.1	0.68008	5.9615616	6.0
14.2	0.68786	6.4858272	6.5
15.3	0.69564	7.0100928	7.0
16.4	0.70342	7.5343584	7.5
17.1	0.7112	7.866624	7.9
17.4	0.71898	8.0068896	8.0
16.7	0.72676	7.6671552	7.7
15.6	0.73454	7.1354208	7.1
14.2	0.74232	6.4596864	6.5
12.9	0.7501	5.831952	5.8
11.4	0.75788	5.1082176	5.1
10.5	0.76566	4.6724832	4.7
9.7	0.77344	4.2847488	4.3
9	0.78122	3.9450144	3.9
8.5	0.789	3.70128	3.7
8	0.79678	3.4575456	3.5
7.7	0.80456	3.3098112	3.3
7.4	0.81234	3.1620768	3.2
7.1	0.82012	3.0143424	3.0
6.8	0.8279	2.866608	2.9
6.7	0.83568	2.8148736	2.8
6.4	0.84346	2.6671392	2.7
6.4	0.85124	2.6634048	2.7
6.2	0.85902	2.5636704	2.6
6.1	0.8668	2.511936	2.5
6	0.87458	2.4602016	2.5
5.9	0.88236	2.4084672	2.4
5.9	0.89014	2.4047328	2.4
5.7	0.89792	2.3049984	2.3
5.7	0.9057	2.301264	2.3
5.4	0.91348	2.1535296	2.2
5.2	0.92126	2.0537952	2.1
4.9	0.92904	1.9060608	1.9
4.7	0.93682	1.8063264	1.8
4.4	0.9446	1.658592	1.7
4.3	0.95238	1.6068576	1.6
4.1	0.96016	1.5071232	1.5
4.1	0.96794	1.5033888	1.5
4.1	0.97572	1.4996544	1.5
4.1	0.9835	1.49592	1.5
4.1	0.99128	1.4921856	1.5
4.1	0.99906	1.4884512	1.5
4	1.00684	1.4367168	1.4
3.8	1.01462	1.3369824	1.3
3.9	1.0224	1.381248	1.4
3.7	1.03018	1.2815136	1.3
3.5	1.03796	1.1817792	1.2
3.4	1.04574	1.1300448	1.1
3	1.05352	0.9343104	0.9
2.8	1.0613	0.834576	0.8
2.5	1.06908	0.6868416	0.7
2.2	1.07686	0.5391072	0.5
2	1.08464	0.4393728	0.4
1.9	1.09242	0.3876384	0.4

RASCAVIEJA

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.4	0.4	0.48	0.5
1.9	0.42	0.7104	0.7
2.2	0.44	0.8448	0.8
2.7	0.46	1.0752	1.1
3.1	0.48	1.2576	1.3
3.5	0.5	1.44	1.4
3.8	0.52	1.5744	1.6
4.3	0.54	1.8048	1.8
4.6	0.56	1.9392	1.9
4.8	0.58	2.0256	2.0
5	0.6	2.112	2.1
5.3	0.62	2.2464	2.2
5.4	0.64	2.2848	2.3
5.6	0.66	2.3712	2.4
5.6	0.68	2.3616	2.4
5.6	0.7	2.352	2.4
5.6	0.72	2.3424	2.3
5.8	0.74	2.4288	2.4
5.8	0.76	2.4192	2.4
6.2	0.78	2.6016	2.6
6.3	0.8	2.64	2.6
6.7	0.82	2.8224	2.8
6.9	0.84	2.9088	2.9
7.1	0.86	2.9952	3.0
7.3	0.88	3.0816	3.1
7.5	0.9	3.168	3.2
7.6	0.92	3.2064	3.2
7.7	0.94	3.2448	3.2
7.8	0.96	3.2832	3.3
7.8	0.98	3.2736	3.3
7.7	1	3.216	3.2
7.7	1.02	3.2064	3.2
7.7	1.04	3.1968	3.2
7.7	1.06	3.1872	3.2
7.7	1.08	3.1776	3.2
7.7	1.1	3.168	3.2
7.9	1.12	3.2544	3.3
7.9	1.14	3.2448	3.2
7.8	1.16	3.1872	3.2
7.9	1.18	3.2256	3.2
7.7	1.2	3.12	3.1
7.4	1.22	2.9664	3.0
7	1.24	2.7648	2.8
6.5	1.26	2.5152	2.5
6.2	1.28	2.3616	2.4
5.8	1.3	2.16	2.2
5.7	1.32	2.1024	2.1
5.6	1.34	2.0448	2.0
5.4	1.36	1.9392	1.9
5.4	1.38	1.9296	1.9
5.4	1.4	1.92	1.9
5.6	1.42	2.0064	2.0
5.7	1.44	2.0448	2.0
5.8	1.46	2.0832	2.1
5.7	1.48	2.0256	2.0
5.8	1.5	2.064	2.1
5.6	1.52	1.9584	2.0
5.1	1.54	1.7088	1.7
4.8	1.56	1.5552	1.6
4.2	1.58	1.2576	1.3
3.8	1.6	1.056	1.1
3.3	1.62	0.8064	0.8
2.8	1.64	0.5568	0.6
2.5	1.66	0.4032	0.4
2.1	1.68	0.2016	0.2

9	0.012	4.31424	4.3
8.5	0.024	4.06848	4.1
8.2	0.036	3.91872	3.9
7.8	0.048	3.72096	3.7
7.3	0.06	3.4752	3.5
7.2	0.072	3.42144	3.4
6.9	0.084	3.27168	3.3
6.8	0.096	3.21792	3.2
6.8	0.108	3.21216	3.2
6.7	0.12	3.1584	3.2
6.6	0.132	3.10464	3.1
6.7	0.144	3.14688	3.1
6.9	0.156	3.23712	3.2
7	0.168	3.27936	3.3
7.1	0.18	3.3216	3.3
7.2	0.192	3.36384	3.4
7.4	0.204	3.45408	3.5
7.5	0.216	3.49632	3.5
7.6	0.228	3.53856	3.5
7.7	0.24	3.5808	3.6
7.8	0.252	3.62304	3.6
8	0.264	3.71328	3.7
8.3	0.276	3.85152	3.9
8.3	0.288	3.84576	3.8
8.5	0.3	3.936	3.9
8.7	0.312	4.02624	4.0
8.8	0.324	4.06848	4.1
8.8	0.336	4.06272	4.1
8.8	0.348	4.05696	4.1
8.6	0.36	3.9552	4.0
8.3	0.372	3.80544	3.8
8	0.384	3.65568	3.7
7.8	0.396	3.55392	3.6
7.2	0.408	3.26016	3.3
6.5	0.42	2.9184	2.9
5.9	0.432	2.62464	2.6
5.3	0.444	2.33088	2.3
4.8	0.456	2.08512	2.1
4.2	0.468	1.79136	1.8
3.8	0.48	1.5936	1.6

RAGATON 1.

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.5	0.4	0.528	0.5
1.9	0.412	0.71424	0.7
2.5	0.424	0.99648	1.0
3	0.436	1.23072	1.2
3.5	0.448	1.46496	1.5
4	0.46	1.6992	1.7
4.5	0.472	1.93344	1.9
4.8	0.484	2.07168	2.1
5.2	0.496	2.25792	2.3
5.8	0.508	2.54016	2.5
5.9	0.52	2.5824	2.6
6.2	0.532	2.72064	2.7
6.5	0.544	2.85888	2.9
6.7	0.556	2.94912	2.9
6.9	0.568	3.03936	3.0
7.1	0.58	3.1296	3.1
7.3	0.592	3.21984	3.2
7.6	0.604	3.35808	3.4
7.8	0.616	3.44832	3.4
8.1	0.628	3.58656	3.6
8.2	0.64	3.6288	3.6
8.4	0.652	3.71904	3.7
8.6	0.664	3.80928	3.8
8.8	0.676	3.89952	3.9
9	0.688	3.98976	4.0
9	0.7	3.984	4.0
9.2	0.712	4.07424	4.1
9.2	0.724	4.06848	4.1
9.5	0.736	4.20672	4.2
9.6	0.748	4.24896	4.2
9.8	0.76	4.3392	4.3
10	0.772	4.42944	4.4
10.1	0.784	4.47168	4.5
10.3	0.796	4.56192	4.6
10.3	0.808	4.55616	4.6
10.4	0.82	4.5984	4.6
10.3	0.832	4.54464	4.5
10.3	0.844	4.53888	4.5
10.2	0.856	4.48512	4.5
10	0.868	4.38336	4.4
9.9	0.88	4.3296	4.3
9.7	0.892	4.22784	4.2
9.6	0.904	4.17408	4.2
9.5	0.916	4.12032	4.1
9.5	0.928	4.11456	4.1
9.7	0.94	4.2048	4.2
10	0.952	4.34304	4.3
10.4	0.964	4.52928	4.5
11.1	0.976	4.85952	4.9
12	0.988	5.28576	5.3
13	1	5.76	5.8
14.6	1.012	6.52224	6.5
16.8	1.024	7.57248	7.6
19.2	1.036	8.71872	8.7
22	1.048	10.05696	10.1
24.8	1.06	11.3952	11.4
26.8	1.072	12.34944	12.3
29.4	1.084	13.59168	13.6
31	1.096	14.35392	14.4
31.4	1.108	14.54016	14.5
30.7	1.12	14.1984	14.2
29.3	1.132	13.52064	13.5
27.2	1.144	12.50688	12.5
25.2	1.156	11.54112	11.5
23	1.168	10.47936	10.5
21	1.18	9.5136	9.5
19.3	1.192	8.69184	8.7
18.2	1.204	8.15808	8.2
17.4	1.216	7.76832	7.8
17	1.228	7.57056	7.6
17.4	1.24	7.7568	7.8
18.5	1.252	8.27904	8.3
19.9	1.264	8.94528	8.9
21.6	1.276	9.75552	9.8
23.6	1.288	10.70976	10.7
25.5	1.3	11.616	11.6
26.9	1.312	12.28224	12.3
28	1.324	12.80448	12.8
28.4	1.336	12.99072	13.0
28.3	1.348	12.93696	12.9
27.5	1.36	12.5472	12.5
26.4	1.372	12.01344	12.0
24.6	1.384	11.14368	11.1
22.8	1.396	10.27392	10.3
20.4	1.408	9.11616	9.1
19.5	1.42	8.6784	8.7
17.5	1.432	7.71264	7.7
15.7	1.444	6.84288	6.8
14.5	1.456	6.26112	6.3
13.1	1.468	5.58336	5.6
12.4	1.48	5.2416	5.2
11.8	1.492	4.94784	4.9
11.5	1.504	4.79808	4.8
11.4	1.516	4.74432	4.7
11.3	1.528	4.69056	4.7
11.2	1.54	4.6368	4.6
11.3	1.552	4.67904	4.7
11.2	1.564	4.62528	4.6
11.2	1.576	4.61952	4.6
11	1.588	4.51776	4.5
10.9	1.6	4.464	4.5
10.5	1.612	4.26624	4.3
10.2	1.624	4.11648	4.1
9.9	1.636	3.96672	4.0
9.5	1.648	3.76896	3.8
9.1	1.66	3.5712	3.6
8.8	1.672	3.42144	3.4
8.4	1.684	3.22368	3.2
8.2	1.696	3.12192	3.1
7.9	1.708	2.97216	3.0
7.6	1.72	2.8224	2.8
7.5	1.732	2.76864	2.8
7.5	1.744	2.76288	2.8
7.4	1.756	2.70912	2.7
7.5	1.768	2.75136	2.8
7.4	1.78	2.6976	2.7
7.6	1.792	2.78784	2.8
7.7	1.804	2.83008	2.8
7.8	1.816	2.87232	2.9
8.1	1.828	3.01056	3.0
8.2	1.84	3.0528	3.1
8.5	1.852	3.19104	3.2
8.6	1.864	3.23328	3.2
9	1.876	3.41952	3.4
9.2	1.888	3.50976	3.5
9.5	1.9	3.648	3.6
9.7	1.912	3.73824	3.7
9.7	1.924	3.73248	3.7
9.8	1.936	3.77472	3.8
9.4	1.948	3.57696	3.6
9.4	1.96	3.5712	3.6

RAGATON 1I

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.2	0.4	0.384	0.4
1.3	0.4097	0.427344	0.4
1.7	0.4194	0.614688	0.6
2.1	0.4291	0.802032	0.8
2.3	0.4388	0.893376	0.9
2.8	0.4485	1.12872	1.1
3	0.4582	1.220064	1.2
3.3	0.4679	1.359408	1.4
3.5	0.4776	1.450752	1.5
3.8	0.4873	1.590096	1.6
4	0.497	1.68144	1.7
4.1	0.5067	1.724784	1.7
4.3	0.5164	1.816128	1.8
4.3	0.5261	1.811472	1.8
4.3	0.5358	1.806816	1.8
4.4	0.5455	1.85016	1.9
4.2	0.5552	1.749504	1.7
4.2	0.5649	1.744848	1.7
4.2	0.5746	1.740192	1.7
4.3	0.5843	1.783536	1.8
4.2	0.594	1.73088	1.7
4.3	0.6037	1.774224	1.8
4.3	0.6134	1.769568	1.8
4.3	0.6231	1.764912	1.8
4.3	0.6328	1.760256	1.8
4.3	0.6425	1.7556	1.8
4.4	0.6522	1.798944	1.8
4.5	0.6619	1.842288	1.8
4.4	0.6716	1.789632	1.8
4.5	0.6813	1.832976	1.8
4.6	0.691	1.87632	1.9
4.8	0.7007	1.967664	2.0
4.9	0.7104	2.011008	2.0
5	0.7201	2.054352	2.1
5.2	0.7298	2.145696	2.1
5.6	0.7395	2.33304	2.3
5.8	0.7492	2.424384	2.4
6.1	0.7589	2.563728	2.6
6.5	0.7686	2.751072	2.8
6.9	0.7783	2.938416	2.9
7.7	0.788	3.31776	3.3
8.5	0.7977	3.697104	3.7
9.4	0.8074	4.124448	4.1
10.7	0.8171	4.743792	4.7
12	0.8268	5.363136	5.4
13.8	0.8365	6.22248	6.2
15.5	0.8462	7.033824	7.0
17.8	0.8559	8.133168	8.1
19.2	0.8656	8.800512	8.8
21.9	0.8753	10.091856	10.1
24	0.885	11.0952	11.1
28.2	0.8947	13.106544	13.1
31.5	0.9044	14.685888	14.7
35.6	0.9141	16.649232	16.6
39.4	0.9238	18.468576	18.5
42.9	0.9335	20.14392	20.1
45.9	0.9432	21.579264	21.6
48.4	0.9529	22.774608	22.8
50.4	0.9626	23.729952	23.7
51.5	0.9723	24.253296	24.3
51.5	0.982	24.24864	24.2
50.2	0.9917	23.619984	23.6
48.2	1.0014	22.655328	22.7
45.8	1.0111	21.498672	21.5
43.8	1.0208	20.534016	20.5
42.3	1.0305	19.80936	19.8
40.9	1.0402	19.132704	19.1
40.7	1.0499	19.032048	19.0
41.1	1.0596	19.219392	19.2
42.3	1.0693	19.790736	19.8
43.8	1.079	20.50608	20.5
45.3	1.0887	21.221424	21.2
46.7	1.0984	21.888768	21.9
48.4	1.1081	22.700112	22.7
49.9	1.1178	23.415456	23.4
51.6	1.1275	24.2268	24.2
53.6	1.1372	25.182144	25.2
55.9	1.1469	26.281488	26.3
58.6	1.1566	27.572832	27.6
61.8	1.1663	29.104176	29.1
66.1	1.176	31.16352	31.2
71.3	1.1857	33.654864	33.7
76.6	1.1954	36.194208	36.2
81.7	1.2051	38.637552	38.6
84.8	1.2148	40.120896	40.1
86.9	1.2245	41.12424	41.1
87.1	1.2342	41.215584	41.2
85.7	1.2439	40.538928	40.5
82.5	1.2536	38.998272	39.0
79	1.2633	37.313616	37.3
74.8	1.273	35.29296	35.3
68.3	1.2827	32.168304	32.2
62.6	1.2924	29.427648	29.4
58.2	1.3021	27.310992	27.3
53.6	1.3118	25.098336	25.1
51	1.3215	23.84568	23.8
49.1	1.3312	22.929024	22.9
48.3	1.3409	22.540368	22.5
48.3	1.3506	22.535712	22.5
48.7	1.3603	22.723056	22.7
48.8	1.37	22.7664	22.8
47.9	1.3797	22.329744	22.3
45.8	1.3894	21.317088	21.3
42.3	1.3991	19.632432	19.6
37.5	1.4088	17.323776	17.3
32.2	1.4185	14.77512	14.8
26.9	1.4282	12.226464	12.2
22	1.4379	9.869808	9.9
17.2	1.4476	7.561152	7.6
12.9	1.4573	5.492496	5.5
10.1	1.467	4.14384	4.1
7.8	1.4767	3.035184	3.0
6	1.4864	2.166528	2.2

CORRECTIONS TO SAMPLE READINGS

MOSTAJO 1A

Rm	DRIFT	0.48*(Rm-DRIFT)	k
0.8	0.4	0.192	0.2
0.9	0.4	0.24	0.2
0.9	0.4	0.24	0.2
1	0.4	0.288	0.3
1.3	0.4	0.432	0.4
1.3	0.4	0.432	0.4
1.6	0.4	0.576	0.6
1.6	0.4	0.576	0.6
1.7	0.4	0.624	0.6
1.8	0.4	0.672	0.7
1.8	0.4	0.672	0.7
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
2	0.4	0.768	0.8
2	0.4	0.768	0.8
2	0.4	0.768	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2	0.4	0.768	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2	0.4	0.768	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.2	0.4	0.864	0.9
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.1	0.4	0.816	0.8
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.1	0.4	0.816	0.8
2.1	0.4	0.816	0.8
2.2	0.4	0.864	0.9
2.1	0.4	0.816	0.8
2	0.4	0.768	0.8
2.1	0.4	0.816	0.8
2	0.4	0.768	0.8
2	0.4	0.768	0.8
2	0.4	0.768	0.8
1.9	0.4	0.72	0.7
1.8	0.4	0.672	0.7
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
2	0.4	0.768	0.8
1.9	0.4	0.72	0.7
1.9	0.4	0.72	0.7
1.8	0.4	0.672	0.7
2	0.4	0.768	0.8
2	0.4	0.768	0.8
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.2	0.4	0.864	0.9
2.3	0.4	0.912	0.9
2.5	0.4	1.008	1.0
2.4	0.4	0.96	1.0
2.5	0.4	1.008	1.0
2.5	0.4	1.008	1.0
2.6	0.4	1.056	1.1
2.7	0.4	1.104	1.1
2.8	0.4	1.152	1.2
2.8	0.4	1.152	1.2
2.9	0.4	1.2	1.2
3	0.4	1.248	1.2
3.2	0.4	1.344	1.3
3.3	0.4	1.392	1.4
3.3	0.4	1.392	1.4
3.4	0.4	1.44	1.4
3.6	0.4	1.536	1.5
3.4	0.4	1.44	1.4
3.5	0.4	1.488	1.5
3.6	0.4	1.536	1.5
3.6	0.4	1.536	1.5
3.6	0.4	1.536	1.5
3.5	0.4	1.488	1.5
3.5	0.4	1.488	1.5
3.5	0.4	1.488	1.5
3.4	0.4	1.44	1.4
3.3	0.4	1.392	1.4
3.3	0.4	1.392	1.4
3.3	0.4	1.392	1.4
3.2	0.4	1.344	1.3
3.2	0.4	1.344	1.3
3.2	0.4	1.344	1.3
3.1	0.4	1.296	1.3
3	0.4	1.248	1.2
3.1	0.4	1.296	1.3
2.9	0.4	1.2	1.2
2.8	0.4	1.152	1.2
2.7	0.4	1.104	1.1
2.6	0.4	1.056	1.1
2.3	0.4	0.912	0.9
2	0.4	0.768	0.8
2	0.4	0.768	0.8
1.7	0.4	0.624	0.6
1.4	0.4	0.48	0.5
1.2	0.4	0.384	0.4
1	0.4	0.288	0.3
0.9	0.4	0.24	0.2

MOSTAJO 2A

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.2	0.4	0.384	0.4
1.3	0.4135	0.42552	0.4
1.4	0.427	0.46704	0.5
1.5	0.4405	0.50856	0.5
1.6	0.454	0.55008	0.6
1.6	0.4675	0.5436	0.5
1.6	0.481	0.53712	0.5
1.6	0.4945	0.53064	0.5
1.6	0.508	0.52416	0.5
1.6	0.5215	0.51768	0.5
1.7	0.535	0.5592	0.6
1.8	0.5485	0.60072	0.6
2	0.562	0.69024	0.7
1.9	0.5755	0.63576	0.6
1.9	0.589	0.62928	0.6
2	0.6025	0.6708	0.7
2.1	0.616	0.71232	0.7
2.2	0.6295	0.75384	0.8
2.3	0.643	0.79536	0.8
2.2	0.6565	0.74088	0.7
2.3	0.67	0.7824	0.8
2.4	0.6835	0.82392	0.8
2.4	0.697	0.81744	0.8
2.4	0.7105	0.81096	0.8
2.4	0.724	0.80448	0.8
2.5	0.7375	0.846	0.8
2.6	0.751	0.88752	0.9
2.7	0.7645	0.92904	0.9
2.7	0.778	0.92256	0.9
2.7	0.7915	0.91608	0.9
2.7	0.805	0.9096	0.9
2.7	0.8185	0.90312	0.9
2.7	0.832	0.89664	0.9
2.7	0.8455	0.89016	0.9
2.7	0.859	0.88368	0.9
2.7	0.8725	0.8772	0.9
2.8	0.886	0.91872	0.9
2.8	0.8995	0.91224	0.9
2.9	0.913	0.95376	1.0
2.9	0.9265	0.94728	0.9
3	0.94	0.9888	1.0
3	0.9535	0.98232	1.0
3.1	0.967	1.02384	1.0
3.1	0.9805	1.01736	1.0
3.1	0.994	1.01088	1.0
3	1.0075	0.9564	1.0
3	1.021	0.94992	0.9
3	1.0345	0.94344	0.9
3.1	1.048	0.98496	1.0
3.1	1.0615	0.97848	1.0
3.2	1.075	1.02	1.0
3.2	1.0885	1.01352	1.0
3.3	1.102	1.05504	1.1
3.4	1.1155	1.09656	1.1
3.4	1.129	1.09008	1.1
3.3	1.1425	1.0356	1.0
3.3	1.156	1.02912	1.0
3.4	1.1695	1.07064	1.1
3.4	1.183	1.06416	1.1
3.5	1.1965	1.10568	1.1
3.5	1.21	1.0992	1.1
3.4	1.2235	1.04472	1.0
3.4	1.237	1.03824	1.0
3.5	1.2505	1.07976	1.1
3.4	1.264	1.02528	1.0
3.4	1.2775	1.0188	1.0
3.4	1.291	1.01232	1.0
3.5	1.3045	1.05384	1.1
3.4	1.318	0.99936	1.0
3.4	1.3315	0.99288	1.0
3.3	1.345	0.9384	0.9
3.3	1.3585	0.93192	0.9
3.2	1.372	0.87744	0.9
3.2	1.3855	0.87096	0.9
3.1	1.399	0.81648	0.8
3	1.4125	0.762	0.8
3.1	1.426	0.80352	0.8
3	1.4395	0.74904	0.7
3	1.453	0.74256	0.7
3	1.4665	0.73608	0.7
2.9	1.48	0.6816	0.7
3	1.4935	0.72312	0.7
3	1.507	0.71664	0.7
3	1.5205	0.71016	0.7
3.1	1.534	0.75168	0.8
3.2	1.5475	0.7932	0.8
3.2	1.561	0.78672	0.8
3.4	1.5745	0.87624	0.9
3.4	1.588	0.86976	0.9
3.5	1.6015	0.91128	0.9
3.5	1.615	0.9048	0.9
3.6	1.6285	0.94632	0.9
3.6	1.642	0.93984	0.9
3.6	1.6555	0.93336	0.9
3.6	1.669	0.92688	0.9
3.6	1.6825	0.9204	0.9
3.6	1.696	0.91392	0.9
3.6	1.7095	0.90744	0.9
3.5	1.723	0.85296	0.9
3.5	1.7365	0.84648	0.8
3.4	1.75	0.792	0.8
3.4	1.7635	0.78552	0.8
3.3	1.777	0.73104	0.7
3.3	1.7905	0.72456	0.7
3.2	1.804	0.67008	0.7
3.2	1.8175	0.6636	0.7
3.2	1.831	0.65712	0.7
3.1	1.8445	0.60264	0.6
3.1	1.858	0.59616	0.6
3	1.8715	0.54168	0.5
3.1	1.885	0.5832	0.6
3.1	1.8985	0.57672	0.6
3.1	1.912	0.57024	0.6
3.2	1.9255	0.61176	0.6
3.2	1.939	0.60528	0.6
3.3	1.9525	0.6468	0.6
3.1	1.966	0.54432	0.5
3.3	1.9795	0.63384	0.6
3.2	1.993	0.57936	0.6
3.3	2.0065	0.62088	0.6
3.3	2.02	0.6144	0.6
3.3	2.0335	0.60792	0.6
3.4	2.047	0.64944	0.6
3.3	2.0605	0.59496	0.6
3.4	2.074	0.63648	0.6
3.4	2.0875	0.63	0.6
3.4	2.101	0.62352	0.6
3.4	2.1145	0.61704	0.6
3.2	2.128	0.51456	0.5
3.2	2.1415	0.50808	0.5
3.3	2.155	0.5496	0.5

MOSTAJO 2B

Rm	DRIFT	0.48*(Rm-DRIFT)	k
0.7	0.4	0.144	0.1
0.9	0.4043	0.237936	0.2
0.7	0.4086	0.139872	0.1
0.8	0.4129	0.185808	0.2
0.9	0.4172	0.231744	0.2
1	0.4215	0.27768	0.3
1.1	0.4258	0.323616	0.3
1.1	0.4301	0.321552	0.3
1.1	0.4344	0.319488	0.3
1.2	0.4387	0.365424	0.4
1.2	0.443	0.36336	0.4
1.3	0.4473	0.409296	0.4
1.3	0.4516	0.407232	0.4
1.4	0.4559	0.453168	0.5
1.5	0.4602	0.499104	0.5
1.6	0.4645	0.54504	0.5
1.7	0.4688	0.590976	0.6
1.8	0.4731	0.636912	0.6
1.9	0.4774	0.682848	0.7
1.9	0.4817	0.680784	0.7
1.9	0.486	0.67872	0.7
1.9	0.4903	0.676656	0.7
2	0.4946	0.722592	0.7
1.9	0.4989	0.672528	0.7
1.9	0.5032	0.670464	0.7
1.9	0.5075	0.6684	0.7
1.8	0.5118	0.618336	0.6
1.8	0.5161	0.616272	0.6
1.7	0.5204	0.566208	0.6
1.8	0.5247	0.612144	0.6
1.9	0.529	0.65808	0.7
1.8	0.5333	0.608016	0.6
1.9	0.5376	0.653952	0.7
1.9	0.5419	0.651888	0.7
1.9	0.5462	0.649824	0.6
1.8	0.5505	0.59976	0.6
1.9	0.5548	0.645696	0.6
1.8	0.5591	0.595632	0.6
2	0.5634	0.689568	0.7
1.9	0.5677	0.639504	0.6
1.9	0.572	0.63744	0.6
2	0.5763	0.683376	0.7
1.9	0.5806	0.633312	0.6
2	0.5849	0.679248	0.7
2	0.5892	0.677184	0.7
2	0.5935	0.67512	0.7
2	0.5978	0.673056	0.7
2	0.6021	0.670992	0.7
1.9	0.6064	0.620928	0.6
2	0.6107	0.666864	0.7
2.1	0.615	0.7128	0.7
1.9	0.6193	0.614736	0.6
2.1	0.6236	0.708672	0.7
2.1	0.6279	0.706608	0.7
2.1	0.6322	0.704544	0.7
2	0.6365	0.65448	0.7
2	0.6408	0.652416	0.7
2.1	0.6451	0.698352	0.7
2.1	0.6494	0.696288	0.7
2	0.6537	0.646224	0.6
1.9	0.658	0.59616	0.6
1.9	0.6623	0.594096	0.6
1.8	0.6666	0.544032	0.5
1.7	0.6709	0.493968	0.5
1.7	0.6752	0.491904	0.5
1.8	0.6795	0.53784	0.5
1.6	0.6838	0.439776	0.4
1.6	0.6881	0.437712	0.4
1.6	0.6924	0.435648	0.4
1.7	0.6967	0.481584	0.5
1.5	0.701	0.38352	0.4
1.6	0.7053	0.429456	0.4
1.6	0.7096	0.427392	0.4
1.7	0.7139	0.473328	0.5
1.6	0.7182	0.423264	0.4
1.6	0.7225	0.4212	0.4
1.8	0.7268	0.515136	0.5
1.8	0.7311	0.513072	0.5
1.8	0.7354	0.511008	0.5
1.9	0.7397	0.556944	0.6
1.9	0.744	0.55488	0.6
1.9	0.7483	0.552816	0.6
2	0.7526	0.598752	0.6
1.9	0.7569	0.548688	0.5
1.8	0.7612	0.498624	0.5
1.9	0.7655	0.54456	0.5
1.7	0.7698	0.446496	0.4
1.7	0.7741	0.444432	0.4
1.8	0.7784	0.490368	0.5
1.8	0.7827	0.488304	0.5
1.8	0.787	0.48624	0.5
1.5	0.7913	0.340176	0.3
1.6	0.7956	0.386112	0.4
1.5	0.7999	0.336048	0.3
1.6	0.8042	0.381984	0.4
1.6	0.8085	0.37992	0.4
1.6	0.8128	0.377856	0.4
1.8	0.8171	0.471792	0.5
1.7	0.8214	0.421728	0.4
1.9	0.8257	0.515664	0.5
2	0.83	0.5616	0.6
2.2	0.8343	0.655536	0.7
2.5	0.8386	0.797472	0.8
2.5	0.8429	0.795408	0.8
2.6	0.8472	0.841344	0.8
2.7	0.8515	0.88728	0.9
2.6	0.8558	0.837216	0.8
2.5	0.8601	0.787152	0.8
2.4	0.8644	0.737088	0.7
2.3	0.8687	0.687024	0.7
2.2	0.873	0.63696	0.6
2.2	0.8773	0.634896	0.6
2	0.8816	0.536832	0.5
1.9	0.8859	0.486768	0.5
1.8	0.8902	0.436704	0.4
1.8	0.8945	0.43464	0.4
1.8	0.8988	0.432576	0.4
1.7	0.9031	0.382512	0.4
1.7	0.9074	0.380448	0.4
1.7	0.9117	0.378384	0.4
1.7	0.916	0.37632	0.4
1.8	0.9203	0.422256	0.4
1.8	0.9246	0.420192	0.4
1.7	0.9289	0.370128	0.4
1.8	0.9332	0.416064	0.4
1.8	0.9375	0.414	0.4
1.8	0.9418	0.411936	0.4
1.8	0.9461	0.409872	0.4
1.6	0.9504	0.311808	0.3
1.6	0.9547	0.309744	0.3
1.4	0.959	0.21168	0.2

MOSTAJO 2A

Rm	DRIFT	0.48*(Rm-DRIFT)	k
3.4	0.0135	1.62552	1.6
3.3	0.027	1.57104	1.6
3.4	0.0405	1.61256	1.6
3.4	0.054	1.60608	1.6
3.4	0.0675	1.5996	1.6
3.4	0.081	1.59312	1.6
3.5	0.0945	1.63464	1.6
3.4	0.108	1.58016	1.6
3.4	0.1215	1.57368	1.6
3.6	0.135	1.6632	1.7
3.5	0.1485	1.60872	1.6
3.5	0.162	1.60224	1.6
3.5	0.1755	1.59576	1.6
3.5	0.189	1.58928	1.6
3.6	0.2025	1.6308	1.6
3.7	0.216	1.67232	1.7
3.6	0.2295	1.61784	1.6
3.6	0.243	1.61136	1.6
3.7	0.2565	1.65288	1.7
3.8	0.27	1.6944	1.7
3.8	0.2835	1.68792	1.7
3.8	0.297	1.68144	1.7
3.7	0.3105	1.62696	1.6
3.8	0.324	1.66848	1.7
3.8	0.3375	1.662	1.7
3.7	0.351	1.60752	1.6
3.7	0.3645	1.60104	1.6
3.8	0.378	1.64256	1.6
3.7	0.3915	1.58808	1.6
3.8	0.405	1.6296	1.6
3.8	0.4185	1.62312	1.6
3.8	0.432	1.61664	1.6
3.9	0.4455	1.65816	1.7
3.9	0.459	1.65168	1.7
4	0.4725	1.6932	1.7
4	0.486	1.68672	1.7
3.8	0.4995	1.58424	1.6
3.8	0.513	1.57776	1.6
3.7	0.5265	1.52328	1.5
3.5	0.54	1.4208	1.4
3.5	0.5535	1.41432	1.4
3.5	0.567	1.40784	1.4
3.5	0.5805	1.40136	1.4
3.4	0.594	1.34688	1.3
3.2	0.6075	1.2444	1.2
3.2	0.621	1.23792	1.2
3.2	0.6345	1.23144	1.2

MOSTAJO 2B

1.4	0.0043	0.669936	0.7
1.4	0.0086	0.667872	0.7
1.3	0.0129	0.617808	0.6
1.3	0.0172	0.615744	0.6
1.1	0.0215	0.51768	0.5
1.2	0.0258	0.563616	0.6
1.2	0.0301	0.561552	0.6
1.1	0.0344	0.511488	0.5

MOSTAJO 3A

Rm	DRIFT	0.48*(Rm-DRIFT)	k
1.3	0.4	0.432	0.4
1.8	0.4178	0.663456	0.7
2.2	0.4356	0.846912	0.8
2.8	0.4534	1.126368	1.1
3	0.4712	1.213824	1.2
3.2	0.489	1.30128	1.3
3.6	0.5068	1.484736	1.5
3.8	0.5246	1.572192	1.6
3.8	0.5424	1.563648	1.6
3.7	0.5602	1.507104	1.5
3.7	0.578	1.49856	1.5
3.7	0.5958	1.490016	1.5
3.6	0.6136	1.433472	1.4
3.5	0.6314	1.376928	1.4
3.6	0.6492	1.416384	1.4
3.5	0.667	1.35984	1.4
3.6	0.6848	1.399296	1.4
3.5	0.7026	1.342752	1.3
3.5	0.7204	1.334208	1.3
3.6	0.7382	1.373664	1.4
3.5	0.756	1.31712	1.3
3.5	0.7738	1.308576	1.3
3.6	0.7916	1.348032	1.3
3.5	0.8094	1.291488	1.3
3.7	0.8272	1.378944	1.4
3.7	0.845	1.3704	1.4
3.9	0.8628	1.457856	1.5
3.9	0.8806	1.449312	1.4
4.2	0.8984	1.584768	1.6
4.1	0.9162	1.528224	1.5
4.2	0.934	1.56768	1.6
4.3	0.9518	1.607136	1.6
4.4	0.9696	1.646592	1.6
4.3	0.9874	1.590048	1.6
4.4	1.0052	1.629504	1.6
4.4	1.023	1.62096	1.6
4.4	1.0408	1.612416	1.6
4.3	1.0586	1.555872	1.6
4.4	1.0764	1.595328	1.6
4.4	1.0942	1.586784	1.6
4.4	1.112	1.57824	1.6
4.4	1.1298	1.569696	1.6
4.4	1.1476	1.561152	1.6
4.5	1.1654	1.600608	1.6
4.5	1.1832	1.592064	1.6
4.4	1.201	1.53552	1.5
4.4	1.2188	1.526976	1.5
4.5	1.2366	1.566432	1.6
4.4	1.2544	1.509888	1.5
4.4	1.2722	1.501344	1.5
4.5	1.29	1.5408	1.5
4.4	1.3078	1.484256	1.5
4.3	1.3256	1.427712	1.4
4.4	1.3434	1.467168	1.5
4.4	1.3612	1.458624	1.5
4.5	1.379	1.49808	1.5
4.7	1.3968	1.585536	1.6
4.6	1.4146	1.528992	1.5
4.7	1.4324	1.568448	1.6
4.8	1.4502	1.607904	1.6
4.7	1.468	1.55136	1.6
4.8	1.4858	1.590816	1.6
4.6	1.5036	1.486272	1.5
4.5	1.5214	1.429728	1.4
4.5	1.5392	1.421184	1.4
4.4	1.557	1.36464	1.4
4.3	1.5748	1.308096	1.3
4.2	1.5926	1.251552	1.3
4.2	1.6104	1.243008	1.2
4.1	1.6282	1.186464	1.2
4.1	1.646	1.17792	1.2
4.1	1.6638	1.169376	1.2
4	1.6816	1.112832	1.1
4	1.6994	1.104288	1.1
3.8	1.7172	0.999744	1.0
3.8	1.735	0.9912	1.0
3.9	1.7528	1.030656	1.0
3.8	1.7706	0.974112	1.0
3.9	1.7884	1.013568	1.0
3.9	1.8062	1.005024	1.0
3.8	1.824	0.94848	0.9
3.9	1.8418	0.987936	1.0
3.7	1.8596	0.883392	0.9
3.8	1.8774	0.922848	0.9
3.8	1.8952	0.914304	0.9
3.8	1.913	0.90576	0.9
3.8	1.9308	0.897216	0.9
3.7	1.9486	0.840672	0.8
3.9	1.9664	0.928128	0.9
4	1.9842	0.967584	1.0
4	2.002	0.95904	1.0
4	2.0198	0.950496	1.0
4.1	2.0376	0.989952	1.0
4.1	2.0554	0.981408	1.0
4.2	2.0732	1.020864	1.0
4.3	2.091	1.06032	1.1
4.3	2.1088	1.051776	1.1
4.4	2.1266	1.091232	1.1
4.4	2.1444	1.082688	1.1
4.4	2.1622	1.074144	1.1
4.4	2.18	1.0656	1.1
4.4	2.1978	1.057056	1.1
4.4	2.2156	1.048512	1.0
4.5	2.2334	1.087968	1.1
4.4	2.2512	1.031424	1.0
4.4	2.269	1.02288	1.0
4.5	2.2868	1.062336	1.1
4.4	2.3046	1.005792	1.0
4.4	2.3224	0.997248	1.0
4.5	2.3402	1.036704	1.0
4.5	2.358	1.02816	1.0
4.3	2.3758	0.923616	0.9
4.3	2.3936	0.915072	0.9
4.4	2.4114	0.954528	1.0
4.3	2.4292	0.897984	0.9
4.3	2.447	0.88944	0.9
4.3	2.4648	0.880896	0.9
4.3	2.4826	0.872352	0.9
4.2	2.5004	0.815808	0.8
4.2	2.5182	0.807264	0.8
4.1	2.536	0.75072	0.8
4.1	2.5538	0.742176	0.7
4.1	2.5716	0.733632	0.7

COTERON

Rm	DRIFT	0.48*(Rm-DRIFT)	k
0.7	0.4	0.144	0.1
1	0.4037	0.286224	0.3
1.2	0.4074	0.380448	0.4
1.2	0.4111	0.378672	0.4
1.2	0.4148	0.376896	0.4
1.4	0.4185	0.47112	0.5
1.3	0.4222	0.421344	0.4
1.4	0.4259	0.467568	0.5
1.5	0.4296	0.513792	0.5
1.5	0.4333	0.512016	0.5
1.5	0.437	0.51024	0.5
1.6	0.4407	0.556464	0.6
1.6	0.4444	0.554688	0.6
1.6	0.4481	0.552912	0.6
1.7	0.4518	0.599136	0.6
1.6	0.4555	0.54936	0.5
1.7	0.4592	0.595584	0.6
1.7	0.4629	0.593808	0.6
1.8	0.4666	0.640032	0.6
1.7	0.4703	0.590256	0.6
1.9	0.474	0.68448	0.7
1.9	0.4777	0.682704	0.7
1.8	0.4814	0.632928	0.6
2	0.4851	0.727152	0.7
1.9	0.4888	0.677376	0.7
2	0.4925	0.7236	0.7
2	0.4962	0.721824	0.7
2	0.4999	0.720048	0.7
2.1	0.5036	0.766272	0.8
2.1	0.5073	0.764496	0.8
2	0.511	0.71472	0.7
2.1	0.5147	0.760944	0.8
2.1	0.5184	0.759168	0.8
2	0.5221	0.709392	0.7
2.1	0.5258	0.755616	0.8
2.2	0.5295	0.80184	0.8
2.1	0.5332	0.752064	0.8
2.2	0.5369	0.798288	0.8
2.2	0.5406	0.796512	0.8
2.2	0.5443	0.794736	0.8
2.3	0.548	0.84096	0.8
2.2	0.5517	0.791184	0.8
2.2	0.5554	0.789408	0.8
2.2	0.5591	0.787632	0.8
2.2	0.5628	0.785856	0.8
2.1	0.5665	0.73608	0.7
2.2	0.5702	0.782304	0.8
2.3	0.5739	0.826528	0.8
2.2	0.5776	0.778752	0.8
2.2	0.5813	0.776976	0.8
2.1	0.585	0.7272	0.7
2.1	0.5887	0.725424	0.7
2.2	0.5924	0.771648	0.8
2.1	0.5961	0.721872	0.7
2	0.5998	0.672096	0.7
2	0.6035	0.67032	0.7
1.9	0.6072	0.620544	0.6
1.8	0.6109	0.570768	0.6
2	0.6146	0.664992	0.7
1.9	0.6183	0.615216	0.6
1.9	0.622	0.61344	0.6
2	0.6257	0.659664	0.7
2.2	0.6294	0.753888	0.8
2.2	0.6331	0.752112	0.8
2.3	0.6368	0.798336	0.8
2.4	0.6405	0.84456	0.8
2.5	0.6442	0.890784	0.9
2.6	0.6479	0.937008	0.9
2.6	0.6516	0.935232	0.9
2.7	0.6553	0.981456	1.0
2.9	0.659	1.07568	1.1
2.9	0.6627	1.073904	1.1
3.1	0.6664	1.168128	1.2
3.2	0.6701	1.214352	1.2
3.3	0.6738	1.260576	1.3
3.4	0.6775	1.3068	1.3
3.6	0.6812	1.401024	1.4
3.8	0.6849	1.495248	1.5
3.9	0.6886	1.541472	1.5
4.1	0.6923	1.635696	1.6
4.2	0.696	1.68192	1.7
4.3	0.6997	1.728144	1.7
4.3	0.7034	1.726368	1.7
4.4	0.7071	1.772592	1.8
4.2	0.7108	1.674816	1.7
4.1	0.7145	1.62504	1.6
4	0.7182	1.575264	1.6
3.9	0.7219	1.525488	1.5
3.9	0.7256	1.523712	1.5
3.7	0.7293	1.425936	1.4
3.7	0.733	1.42416	1.4
3.7	0.7367	1.422384	1.4
3.7	0.7404	1.420608	1.4
3.6	0.7441	1.370832	1.4
3.6	0.7478	1.369056	1.4
3.4	0.7515	1.27128	1.3
3.4	0.7552	1.269504	1.3
3.1	0.7589	1.123728	1.1
3.1	0.7626	1.121952	1.1
3.1	0.7663	1.120176	1.1
2.8	0.77	0.9744	1.0
2.3	0.7737	0.732624	0.7
2.1	0.7774	0.634848	0.6
1.8	0.7811	0.489072	0.5
1.5	0.7848	0.343296	0.3
1.3	0.7885	0.24552	0.2

4	0.0178	1.911456	1.9
3.9	0.0356	1.854912	1.9
3.8	0.0534	1.798368	1.8
3.8	0.0712	1.789824	1.8
3.7	0.089	1.73328	1.7
3.6	0.1068	1.676736	1.7
3.5	0.1246	1.620192	1.6
3.4	0.1424	1.563648	1.6
3.3	0.1602	1.507104	1.5
3.2	0.178	1.45056	1.5
3	0.1958	1.346016	1.3
3.1	0.2136	1.385472	1.4

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