COVADONGA NATIONAL PARK (WESTERN MASSIF OF PICOS DE EUROPA, NW SPAIN): A CALCAREOUS DEGLACIATED AREA

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TRABAJOS DE GEOLOGIA

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Las áreas montañosas de la Península Ibérica se caracterizan por presentar un relieve glaciar y periglaciar, consecuencia de los cambios climáticos que tuvieron lugar durante el Pleistoceno. Este relieve, aunque ligeramente modificado, también se puede reconocer en las partes elevadas de la Cordillera Cantábrica.

Los efectos de estos procesos glaciares y periglaciares fueron parcialmente controlados por la litología del sustrato. En las zonas calcáreas, la karstificación, activa durante y después de la glaciación, afectó no sólo el desarrollo de las formas glaciares y periglaciares sino también a su conservación. En el macizo de Picos de Europa, formado casi exclusivamente por calizas carboníferas, las formas erosivas glaciares, principalmente a gran escala, mezcladas con formas kársticas alcanzaron un desarrollo importante. Sin embargo, los depósitos glaciares son escasos: las morrenas se conservan principalmente en las zonas bajas. La respuesta de estas calizas a las condiciones periglaciares fue pequeña. Los glaciares rocosos, frecuentes en las áreas siliciclásticas de la Cordillera, no se desarrollaron en Picos de Europa. Durante y después de la deglaciación, se produjeron avalanchas de rocas en las áreas calcáreas mientras que las rocas siliciclásticas sufrieron deslizamientos rotacionales.

Palabras clave: glaciokarst, Parque Nacional de Covadonga, Picos de Europa, Cordillera Cantábrica.

The climatic cooling of the Pleistocene that resulted in the Scandinavian and Alpine glaciers also affected the mountainous areas of the Iberian Peninsula, the Cantabrian Cordillera among them. Those climatic changes originated a glacial and periglacial landscape that, although slightly modified, is still preserved.

The effects of these glacial and periglacial processes were partially controlled by the lithology of the substratum. The karstification, active during and after glaciation, affected not only the development of the glacial and periglacial forms but also their preservation. In calcareous areas of the Cantabrian Cordillera, such as Picos de Europa massif, composed almost entirely of carboniferous limestones, glacial erosional forms, mainly large scale, mixed with karst landforms reached major development. There are, however, minor glacial deposits: moraines are present only at lower elevations. The response of these limestones to periglacial conditions was minimal. Rock glaciers, common in siliciclastic areas of the Cordillera, did not develop in Picos de Europa. During and after deglaciation, the limestones were subject to rockfalls whereas siliciclastic rocks were likely to undergo rotational landslides.

Key words: glaciokarst, Covadonga National Park, Picos de Europa, Cantabrian Cordillera.

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INTRODUCTION

Picos de Europa is a high massif located in the Cantabrian Cordillera of the northwestern Iberian Peninsula. Despite the high elevation of Picos de Europa, the headwaters of the rivers in this area lie to the south, where elevations are similar to the ones inside the massif. The Duje and Cares Rivers, flowing north to the Cantabrian Sea from their headwaters, cross Picos de Europa and divide them into three big units known from east to west as: Macizo Oriental (Eastern Massif), Macizo Central (Central Massif), and Macizo Occidental (Western Massif) (**Fig. 1**).

Covadonga National Park (C.N.P.), the oldest in the Iberian Peninsula and one of the first in Europe, occupies most of the Macizo Occidental. It has an approximate area of 170 km^2, and its highest peak, Peña Santa de Castilla (2596 m), is only 30 km from the coast.

Due to this proximity to the sea and to the climatic barrier created by the mountainous alignment, the massif has considerable cloudiness and heavy precipitation (with snowfalls during the winter), specially in the north half of the massif. At present, there are perennial snowpatches in protected areas. In colder times of the past, these climatic characteristics and the high elevations provided favorable conditions for glaciation. Glacial ice, under snow, has recently been found in the Macizo Central, and it probably exists also in the Macizo Occidental (González Suárez and Alonso, 1994).

Glacial and periglacial landforms are common to all uplands in the Cantabrian Cordillera, although in Picos de Europa this landscape is partially masked due to the lithologic composition. As the substrate is formed mainly of calcareous rocks, karstification is mixed with glacial and periglacial processes and therefore Picos de

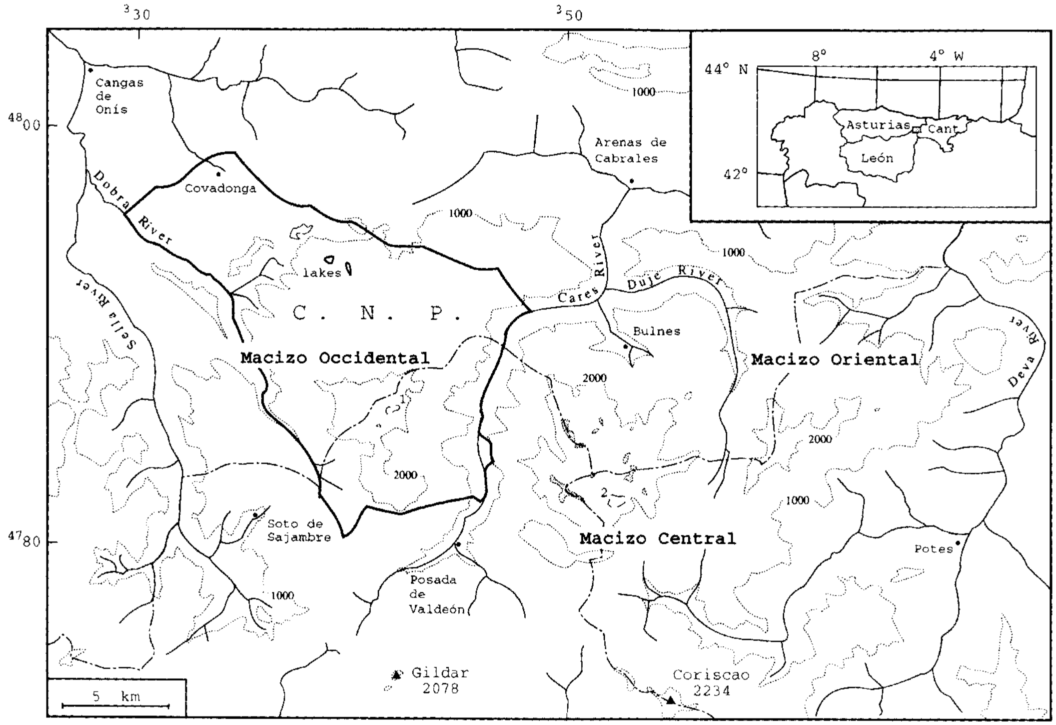

Fig. 1.– Location of Picos de Europa massif and Covadonga National Park. Contour interval = 1000 m. Stippled areas above 2500 m. Main joos of Macizo Occidental and Macizo Central also represented: 1. Jou Santo, 2. Hoyo sin Tierra.

Europa have a more complex geomorphology than in the rest of the Cantabrian Cordillera.

By studying the landscape of C.N.P. and by comparing it with the morphology of siliciclastic areas of the Cantabrian Cordillera, it is possible to note variations controlled by the lithology, in the manifestation of the glacial and periglacial conditions and in the development of the different forms associated with these processes.

GEOLOGICAL SETTING

The Hercinian Massif was divided by Lotze (1945) into several zones, the Cantabrian Zone among them. A further division was made by Julivert (1967) who, considering tectonic and stratigraphic characteristics, distinguished five big geological units in the Cantabrian Zone. Three of these units are represented in the Macizo Occidental of Picos de Europa: Picos de Europa Unit, Ponga Unit, and Pisuerga Carrión Unit.

Most of the area of C.N.P. is within the Picos de Europa Unit (**Fig. 2**). The stratigraphic units that form most of the substrate of the Park were studied by Maas (1974), Farias (1982), Martínez García and Rodríguez Fernández (1984), and Marquínez (1990).

The sequence commences with the Oville Formation, comprised of shales and glauconitic limestones with a minimum thickness of 50 m (**Fig 3**). Above is the Cambro-Ordovician Barrios Formation, composed of 650 m of white quartz arenites, with some shales, siltstones and conglomerates interbedded. Overlying them are two thin formations: the Ermita Formation of quartz arenites and microconglomerates, and the Portillas Limestone of white and light grey color with encrinitic levels.

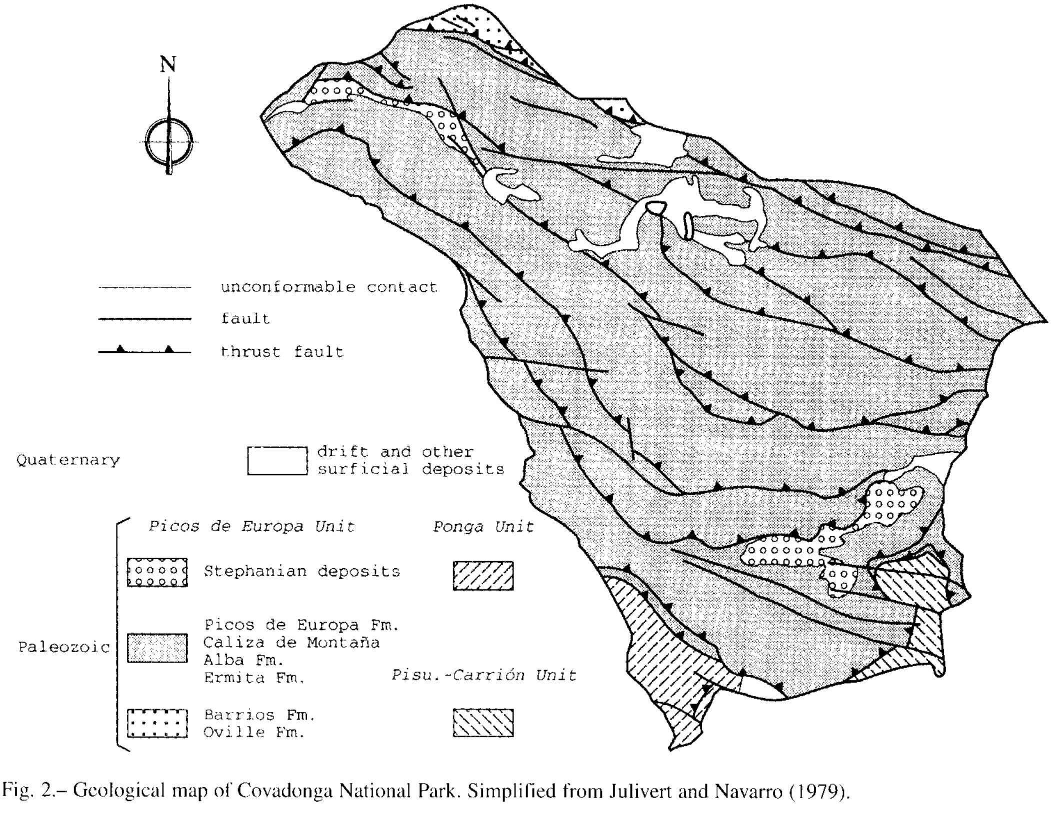

Fig. 2.– Geological map of Covadonga National Park. Simplified from Julivert and Navarro (1979).

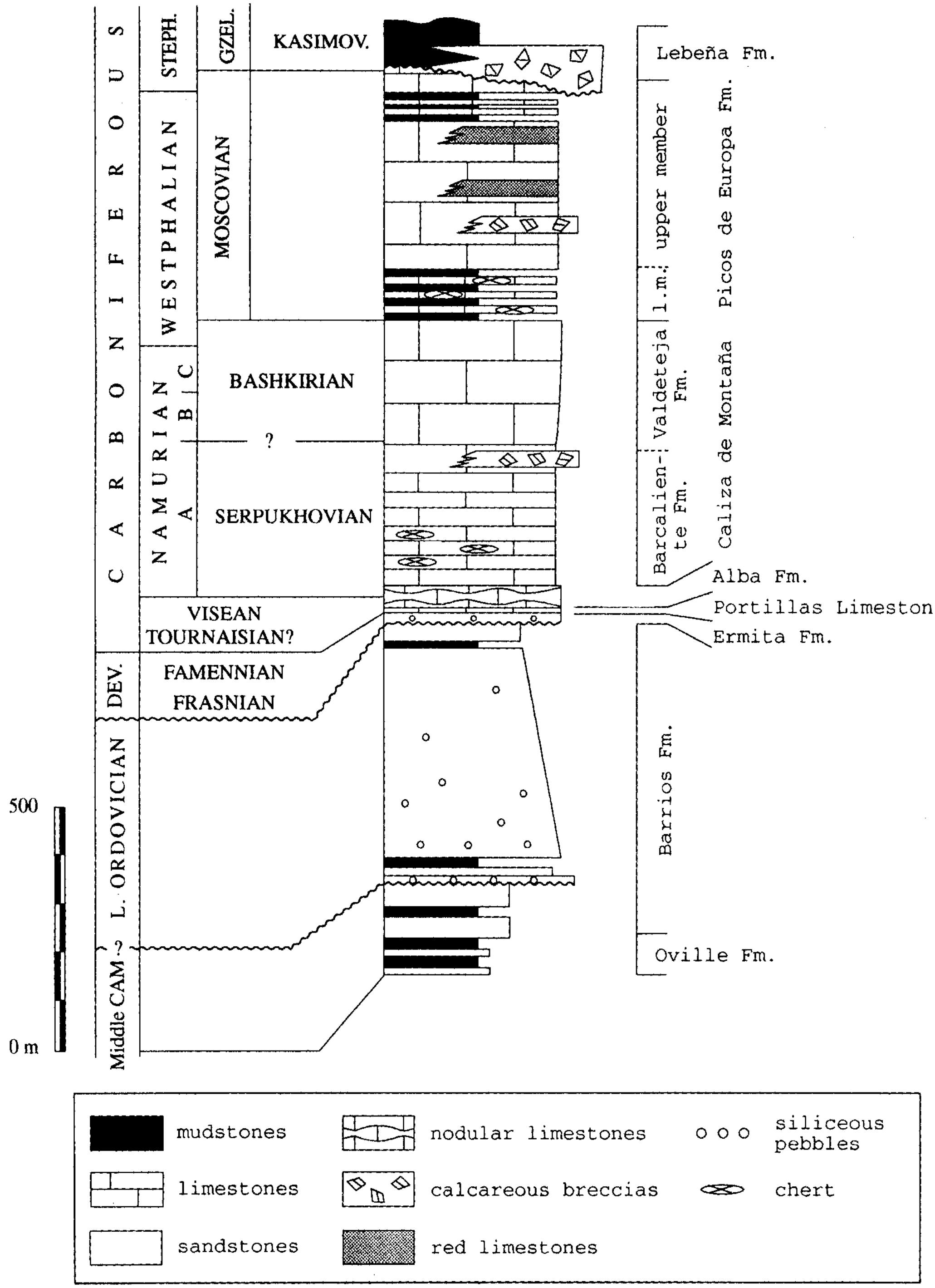

Fig. 3.– Generalized stratigraphic column for the area of Covadonga National Park. Based in Marquínez (1978), Farias (1982) and Aramburu (1989).

The base of the Carboniferous series, the Alba Formation, consists of nodular limestones with lutitic intercalations and red radiolarites interbedded in the middle part. There is a gradual change to the Caliza de Montaña, composed of two formations: the Barcaliente Formation of dark grey, finely laminated bedded micritic and biomicritic limestones with a thickness of 60-80 m, passing gradually to the Valdeteja Formation with fossiliferous and bioclastic, massive limestones, with a thickness of 300-550 m. The Picos de Europa Formation also has two parts: a lower member of dark, bioclastic laminated limestones, often interbedded with chert, and an upper member of light, massive limestones, interbedded with reddish encrinitic limestones. The total thickness of these two members is 500 m. Finally, Stephanian deposits lie unconformally above; these are calcareous conglomerates and breccias, bioclastic limestones, calcareous arenites, shales, and siliceous conglomerates. Quaternary materials include drift, periglacial deposits, colluvium, and decalcification deposits; they have an unequal distribution and are more common in the lower areas.

As shown on the geological map (**Fig. 2**), this region is dominated by calcareous Carboniferous rocks. The great sequence of limestones, thickened by a thrust complex, is in contact to the south with the Pisuerga-Carrión Unit. This unit is formed of dominantly siliceous materials also of Carboniferous age (conglomerates, sandstones, shales, and some limestones) that creates a strong lithological contrast. The geological structure of the Picos de Europa is very complicated. Numerous thrusts formed during the Variscan orogeny are the main structure; they run NW-SE in the western part and E-W in the eastern part. There are also some alpine faults affecting these thrusts.

PHYSIOGRAPHIC FEATURES

The most important morphologic features in this area are of fluvial, glacial, and karstic origin.

Being a calcareous massif, there is a complex groundwater flow with paths not well known yet; the groundwater basins correspond only partially to the ones of surface waters. The incomplete development of the surface drainage basins was caused by karstification. There are blind valleys and large closed depressions, most of them of glacio-karst origin, locally known as «jou» (plural, «joos»).

The Cares River to the east, as well as the Dobra River that constitutes the SW limit of C.N.P., are deeply incised into the calcareous rocks. In the Cares Gorge, the relief in short horizontal distances is up to 1500 m, to the west in the Macizo Occidental, as well as to the east in the Macizo Central. The Cares River cuts the Hercynian structures while the Dobra flows more or less parallel to them.

In C.N.P. seven geomorphic units were distinguished (**Fig. 4**). The main drainage divide within C.N.P. extends NW and NE from the highest point in the massif, Peña Santa de Castilla. This divide separates the North Zone from the other six geomorphic units, and constitutes a very important barrier from a climatic viewpoint.

C.N.P. as a whole is characterized by a complex landscape where the alignments of most of the erosional landforms are structurally controlled. The surface of the massif is quite smooth in some areas (**Fig. 5**). Elsewhere rugged uplands alternate with deep depressions; the smoothed profiles of the depressions are in part due to local filling with debris of varied origins.

In the higher zones the glacial forms prevail over the karstic forms; they constitute a Pleistocene glaciokarst. And, although the glaciokarst at present is being dissected by active processess, it is still possible to recognize glacial forms, specially those of large size. The lower portion in the North Zone represents a fluviokarst where fluvial forms are mixed with karstic forms.

GLACIAL GEOMORPHOLOGY

Glacial features in Picos de Europa were already known early in this century (Obermaier, 1914; Hernández Pacheco, 1914); since then, many studies have been conducted. An important contribution is the one by Miotke (1968) on the karst of the Macizo Occidental, that includes some aspects on the Quaternary glaciation of the area. The increasing interest in the glacial geology of the Cantabrian Cordillera is reflected in the studies made on this massif by Marquínez (1990), Alonso (1992), and Flor (1992), among others.

In relation to glaciation, the most notable characteristic of C.N.P. is the small amount of deposits covering the bedrock surface (**Figs. 6 and 7**). Large scale erosional forms, on the other hand, are well developed, specially in the higher areas. There are numerous cirques and glaciokarst depressions («joos») that acted as snow accumulation areas.

Cirque floors are at different altitudes (1350-1900 m) and their aspect shows great variability (**Fig. 4**). An analysis of cirque aspects points to structural control of cirque disposition, as there is a relation between aspect and the joint pattern given by Marquínez (1990).

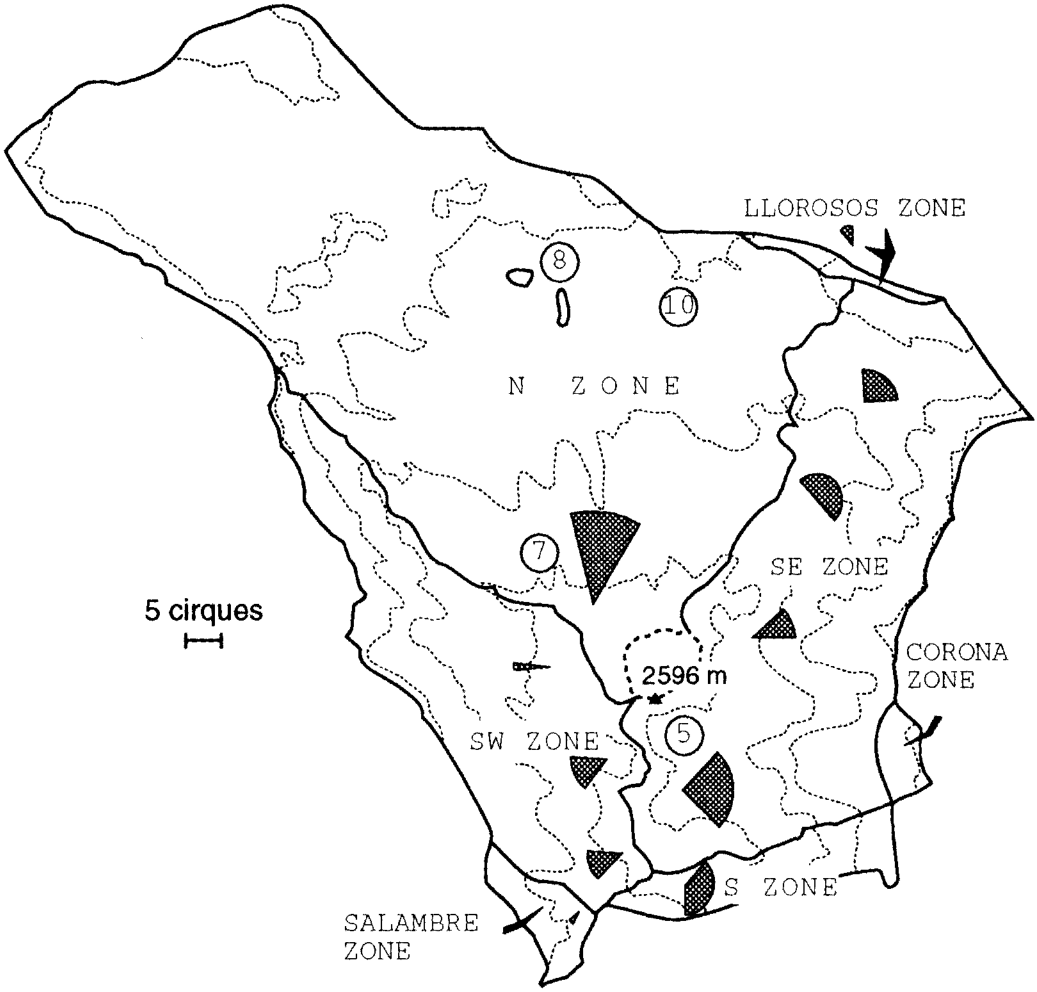

Fig. 4.- Geomorphic units of Covadonga National Park showing cirque aspects. Numbers indicate locations of the central parts of the photos.

During glaciation, snow accumulation took place not only in cirques but also in glaciokarst depressions. According to Smart (1986), these are the major large scale landforms in the Macizo Oriental. Possible origins of the joos include:

1. the biggest joos, elliptical or circular in plan up to 1300 m across, are located in zones of close fracturing that would be already lowered by karstification before their occupation by glacier ice. During glaciation the deepening would proceed farther due to physical processes (glacier overexcavation) and chemical processes (solution by subglacial melt water), as subglacial flow would converge to the axial zones of these depressions (Smart, 1986). After ice retreat joos continue evolving for they are favorable areas for snow accumulation. Thus, they are nival-glacio-karstic forms. This hypothesis coincides with the one given by Nicod (1976) for the glaciokarst depressions in Grostedi, Italy;
2. some other joos, smaller in size and located close to the glacial divides, are essentially modified cirques. Solution by meltwater deepened these joos. Following Ford's (1979) classification they are karstiglacial forms, also with nival influence;
3. in very few cases, joos are dolines with little erosion by ice.

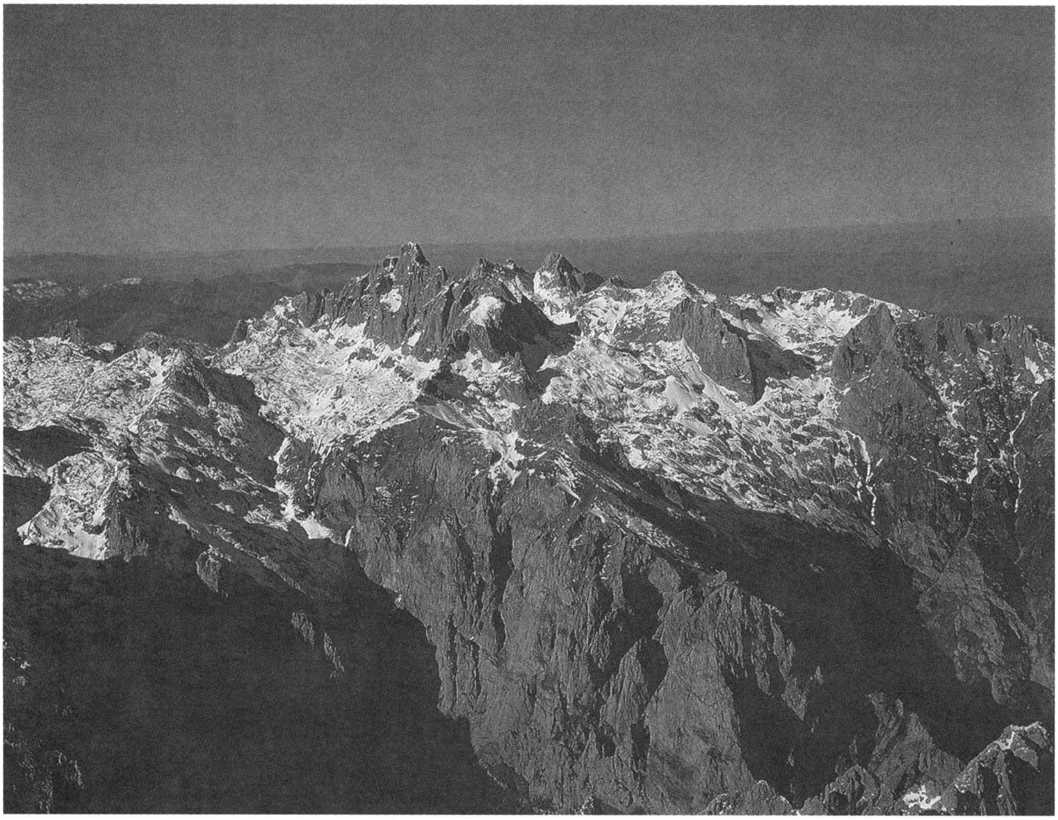

Fig. 5.– Aerial view from the Macizo Central of the SE Zone showing the south face of Peña Santa de Castilla (the highest peak). Notice the difference between the polished areas that were ice-covered and the rough peaks. The Cantabrian Sea is in the background. (Photograph by L. Montoto).

Medium-scale features, such as smooth areas and polished surfaces, are partially dissected by karstification. It was not possible to find striations or other minor features in this massif due to the high rates of solution of the limestone in Picos de Europa that, according to Garay Martín and Morell Evangelista (1989) and to García Codrón (1989), are the highest in the Spanish karstic systems. Striations, however, have been found in the Macizo Central in rocks that were covered by debris until recently.

Also because of the lithology, the topography is not organized in thalwegs and water divides. There is, however, a net of interlaced valleys with irregular longitudinal profiles. They frequently have U-shaped cross-sections characteristic of glaciated valleys; examples are Ordiales, Cebolleda (**Fig. 7**), the upper part of the Resecu, or Enol Valley (**Fig. 8**), all of them in the North Zone.

During the cold periods of the Pleistocene C.N.P. was covered with several glacial systems, the locations controlled by preexisting topography (**Fig. 6**). The glaciers radiated down from the higher areas and ice flow followed, in general, the main fracture directions, which had already determined the former landscape.

During the maximum of the glaciation there were small ice caps covering the higher areas. Some of the successive positions of the ice mar-

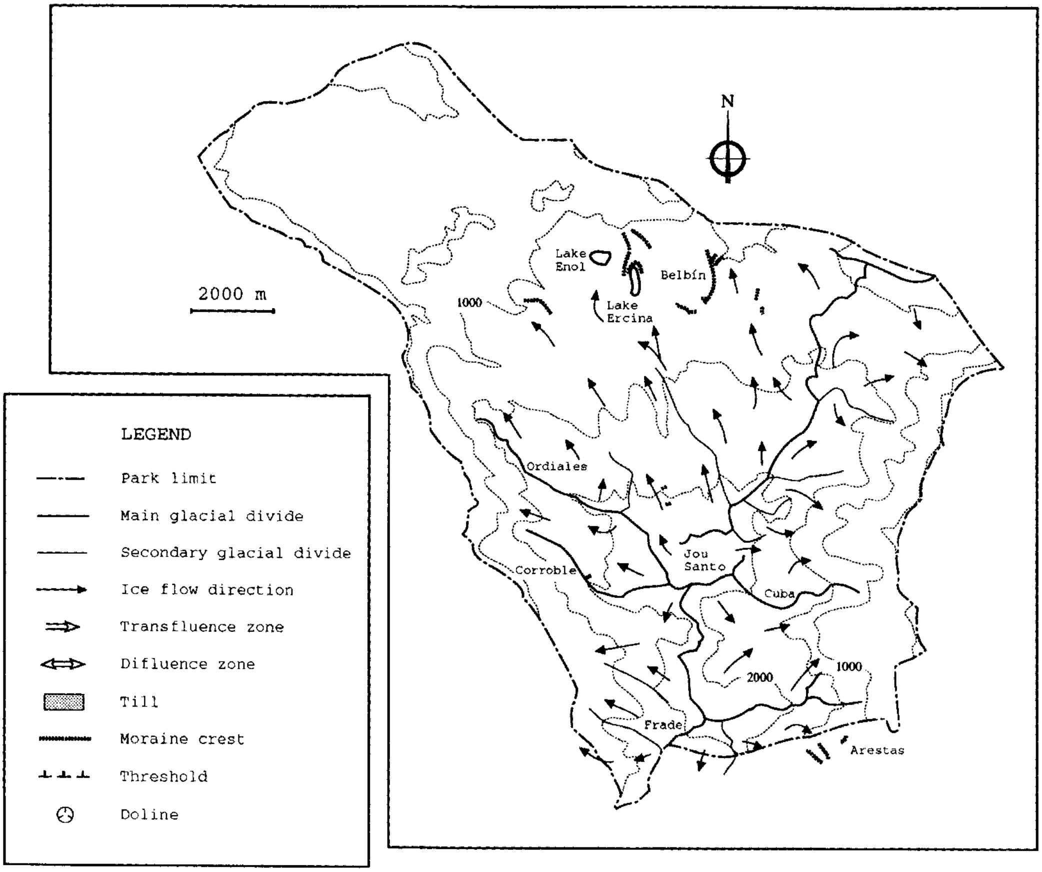

Fig. 6.– Main glacial systems defined in Covadonga National Park, showing ice-flow movement directions and distribution of moraines.

gins, during the deglaciation, are recorded by morainic deposits. Only those of Lakes Enol and Ercina (**Figs. 6, 8 and 9**), at about 1000 m in the North Zone, and those at Pambuches (1220 m) and Arestas (1150 m) in the South Zone, indicate the limit of the glacier front, as they are end moraines. Ice may have extended farther downvalley than where the best-developed moraines are located (Flor, 1992; Miotke, 1993, pers. comm.). Well-developed lateral moraines in the North Zone at Belbín (**Fig. 10**) and Pandecarmen also indicate a minimum elevation for the glaciers of about 1000 m.

The volume of deposits diminishes toward the central parts of the massif; most of the surface is bedrock. In these areas, it is very difficult in many cases to distinguish between glacial and decalcification deposits, as there are not outcrops to observe their characteristics and they do not have a morainic morphology.

In the central parts, however, ice margins were sometimes registered by elongate depressions formed by karstification by meltwater. These depressions, transverse to the ice-flow direction, usually are convex down-glacier. They originated during the glacier retreat, when large volumes of melwater were flowing from the outer margins of the ice. A relation between end moraines and elongated depressions, both produced in ice-marginal areas, can be seen in a zone located north of Llorosos, north of C.N.P.: two end moraines continue laterally with rock thresholds that bound depressions (**Fig. 11**).

Glacial features are identified in most of C.N.P. except in the lower areas of the North Zone. It is not possible, however, to establish accurately the outer limits of glaciation because of significant post-glacial modification of glacial landforms. In particular, karst processes have caused solution of glacial erosional landforms. There is good preservation of moraines, although till textures have been modified by karstification, at least near the surface.

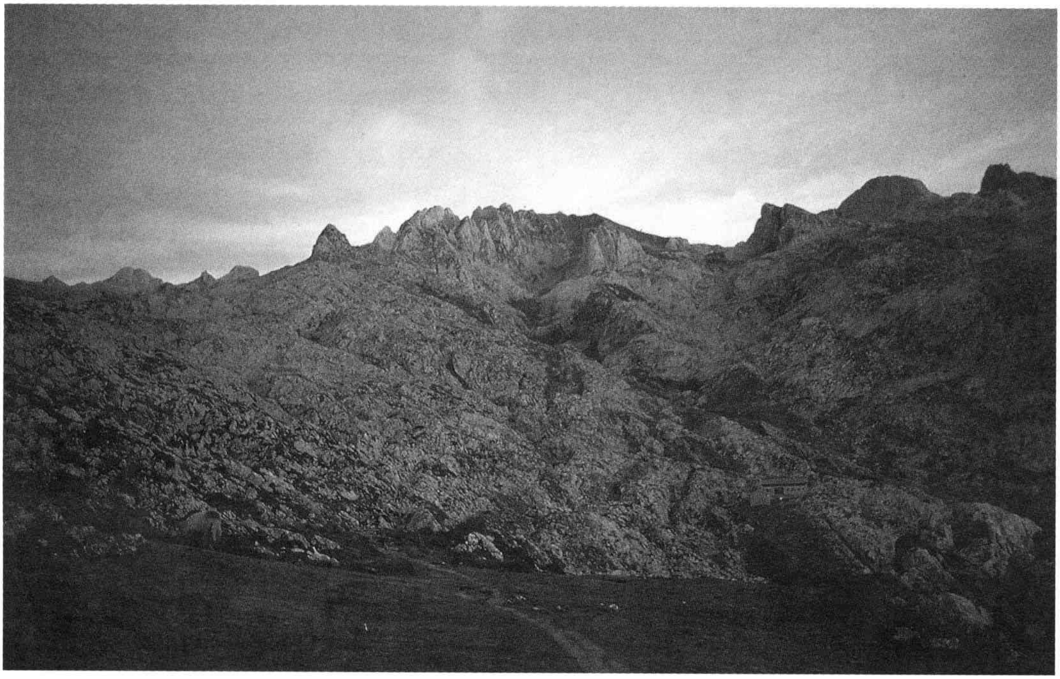

Fig. 7.– Refuge of Vegarredonda and Cebolleda area. Most of the uplands of this massif are devoid of deposits. Glacial cirques and valleys are generally well preserved, as the one of Cebolleda in the North Zone.

PERIGLACIAL GEOMORPHOLOGY

After the disappearance of most Pleistocene glaciers on the Iberian Peninsula, there was a cold dry phase. This phase, dated by Martí and Serrat (1990) in the Spanish Pyrenees between 13000 and 10000 years BP, was characterized by the formation of rock glaciers. These are widely distributed in the Cantabrian Cordillera, but there are also other periglacial forms such as protalus ramparts, solifluction tongues and patterned ground.

Periglacial forms are not common in C.N.P. There are, however, some nivation hollows, similar to dolines, although they are not complete closed depressions. In spite of the high altitudes of this massif, detritus volume covering rock surfaces is small. These relatively massive limestones are not prone to frost weathering.

In the upper areas, protalus ramparts are relatively common. They possess S to SW aspects. Although these orientations may not seem favorable, they are subject to high insolation during the day and have strong temperature variations. This fact as well as water availability favor the rock fall from the cliffs that feeds protalus ramparts. Cliffs with N to NE aspects, with small thermal variations, have a smaller number of freeze-thaw cycles, and therefore generally produced less colluvium.

Fig. 8.– Aerial view of the area around the lakes. In the foreground are Enol Lake and the U-shaped Enol valley. Well developed terminal moraines of Ercina Lake (this one partially hidden) were affected in its eastern part by mining activity. The highest peak with snow is Llorosos (1,792 m). Half between Ercina lake and Llorosos the lateral moraines of Belbín (Photograph by L. Montoto).

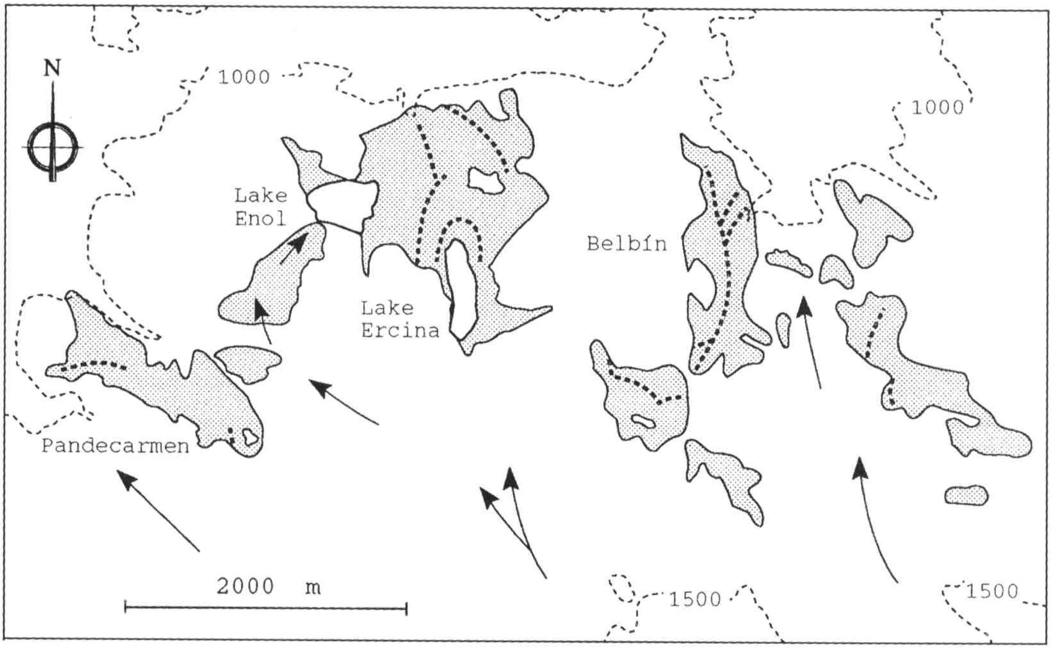

Fig. 9.– Distribution of end and lateral moraines in the area around the lakes. (For legend see fig. 6).

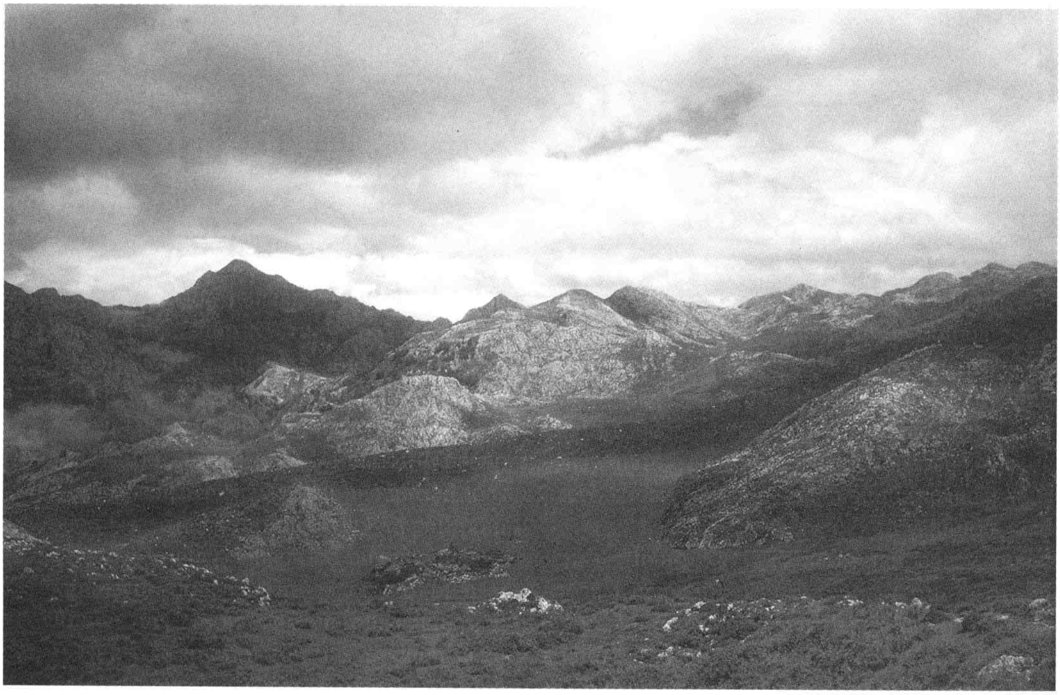

Fig. 10.– View to the east of the lateral moraines of Belbín (Llorosos in the back, to the left). The western moraine obturated the area now occupied by the sheep-fold of Belbín, an important pasture zone.

Rock glaciers were not formed in the Macizo Occidental, although the landscape of the areas that were not buried by ice was rough after deglaciation. However, they are frequent in other siliciclastic areas of the Cantabrian Cordillera, even in nearby zones (Alonso, 1989, 1992), as in the Gildar zone, located to the south of C.N.P. The Gildar, with lower altitudes but a siliciclastic susbtrate, has rock glaciers above 1400 m.

Solifluction processes, affecting the Stephanian clastic materials, occur near the lakes at 1200 m and in Cuba (SE Zone) at 1750 m. These deposits form tongues up to 200 m long, on slopes with a north aspect and gradients up to 50°.

There is evidence of present periglacial activity at altitudes above 1500 m, shown by small scale features. In the Frade proximity, there are terracettes of *Luzula caespitosa* and *Festuca esquia* on the same substrate that developed solifluction tongues. There are also terracettes of *Carex sempervirens* on glacier deposits in the higher areas and of *Carex sempervirens* and

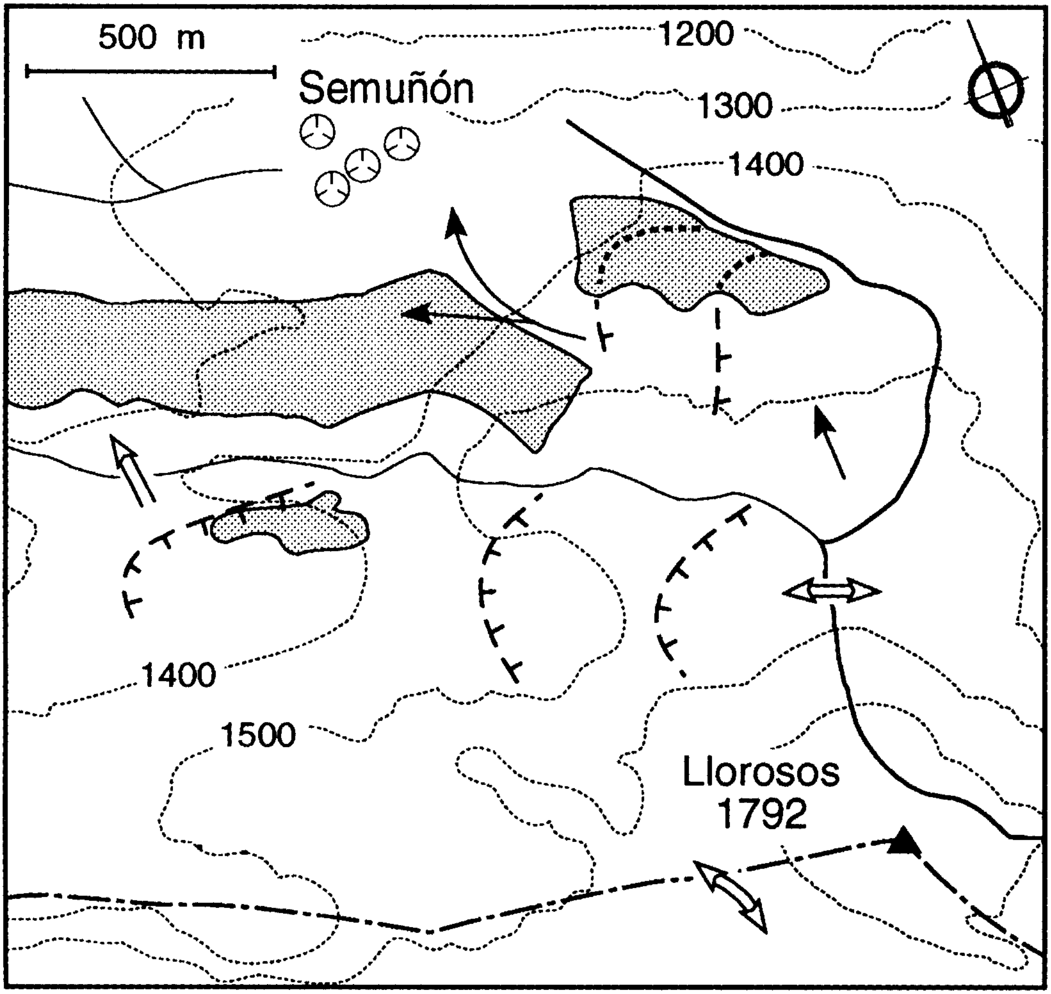

Fig. 11.– Relationship between end moraines and rock thresholds in the area of Llorosos, north of C.N.P. (For legend see fig. 6).

Anthyllis vulneraria in calcareous talus slopes. In areas exposed to wind action at 2200 m, there are stone steps formed by wind erosion similar to those described by Holtmeier (1978) in the Colorado Front Range. According to Troll (1973), these periglacial forms can be formed at altitudes above 2400 m in the Pyrenees and above 2000 m in central Spain.

POSTGLACIAL FEATURES

Besides glacial and periglacial deposits, at high elevations in C.N.P. there are accumulations of large rock fragments (up to 4 m in size), of irregular shape, located below cliffs. As these accumulations are in some cases at some distance from the bases of the slopes, they could be confused with protalus ramparts. They are interpreted as rockfalls that occurred after deglaciation, probably caused by reduction in lateral support when the ice melted.

In C.N.P., detrital accumulations at the foot of cliffs, such as talus slopes and debris cones, usually devoid of vegetation, are frequently cut by channels. The detrital accumulations are at elevations between 1100 and 2100 m, and the heads of the channels, excavated in the cliffs, extend up to 2150 m. Through the channels, their positions controlled by fractures, debris from the cliffs or from Quaternary unconsolidated deposits, is transported by mass wasting and torrential activity to more stable positions, reaching in some cases the fluvial net. This type of process is more frequent in the SE, S, and SW Zones, with higher reliefs in short distances.

DISCUSSION AND CONCLUSIONS

The geomorphological analysis of this calcareous deglaciated area in the Cantabrian Cordillera has shown some differences in the development and preservation of glacial and periglacial features, compared with nearby areas with siliciclastic bedrock.

The glacial landscape, more complex than one formed on siliclastic bedrock, has been partially modified by postglacial karstification. The strong structural control on the erosional glacial forms in this area can be attributed to the relatively massive substratum. This relation between fracturing and karstic and glacial features has been found also in the Pyrenees (García Codrón, 1983) and in the Canadian Rockies (Smart, 1983).

Moraines are better preserved than in other areas, probably due to the poor development of the fluvial net; in siliciclastic zones fluvial erosion has contributed to their erosion. The volume of moraines, however, considering the size of the glaciers that originated them, is very small. This lack of glacial deposits in C.N.P. can be explained by the fact that only some arêtes and peaks, sources for supraglacial debris, were above the ice in the upper areas (**Fig. 5**). On the other hand, materials transported at the glacier bed could have been partially introduced into caverns. According to the observations of Smart (1984) for the Macizo Oriental, caverns had already formed before glaciation. Also Walder and Hallet (1979) and Hallet and Anderson (1980) point to the scarce till on recently calcareous deglaciated zones.

Few periglacial landforms were produced in the areas with Carboniferous limestones. There are very few protalus ramparts, and solifluction processes are limited mainly to detrital formations. Rock glaciers were not recognized in these limestones, although they are present in the Gildar Mountains. In the Cantabrian Cordillera the only known rock glaciers formed of calcareous debris are adjacent to outcrops of limestones of Devonian age (Santa Lucía Formation).

Rockfalls, but not rotational slides that, in general, are more frequent elsewhere in this Cordillera, contributed to slope stabilization after deglaciation. As pointed out by Gardner (1982) and Gardner *et al.* (1983) postglacial slope stability can be reached not only by slides, but also by the fall of large blocks. At least some of the rockfalls in C.N.P. are contemporary with the formation of antislope scarps characteristic of ridge crests with siliciclastic substratum that, according to Alonso and Corte (1992), are the heads of rotational slides. An increase of joints parallel to the surface, in some of the deglaciated areas, could be interpreted as a minor effect of the postglacial relaxation. Joints parallel to a cliff face were also found in Castleguard, Canadian Rockies (C.C. Smart, 1991, pers. comm.).

Channels cuting talus slopes and debris cones are also characteristic of calcareous terrains. These type of channels and associated deposits, also quite frequent in the French Alps (Van Steijn, 1988 and Van Steijn *et al.*, 1988), were related by those authors to the heavy rains that fall during the summer. In this area, as Gardner (1986) proposed for the Canadian Rockies, water forming these ephemeral streams can be provided by snowmelt in spring and by rainstorms during summer. There are very few climatological data for Picos de Europa, but highest precipitation values from 1980 recorded in Valdeón were 4.41 mm/h for a period of 24 hours, and 5.78 mm/h for 8 hours. Using the formula of Caine (1980) these intensities are very close to the minimal threshold to produce surficial slope instability.

Glacial and periglacial landforms have been modified by karst and fluvial processes and present periglacial activity. Karstification has produced different types of karren forms on deglaciated surfaces and glacial deposits have changed their original textures due to solution and precipitation processes. Intermittent fluvial activity provoked by heavy rains and snowmelt is locally eroding glacial and slope deposits. In the uplands there are periglacial processes, affecting mainly surficial materials over 1750 m, where terracettes are forming on calcareous and siliceous soils.

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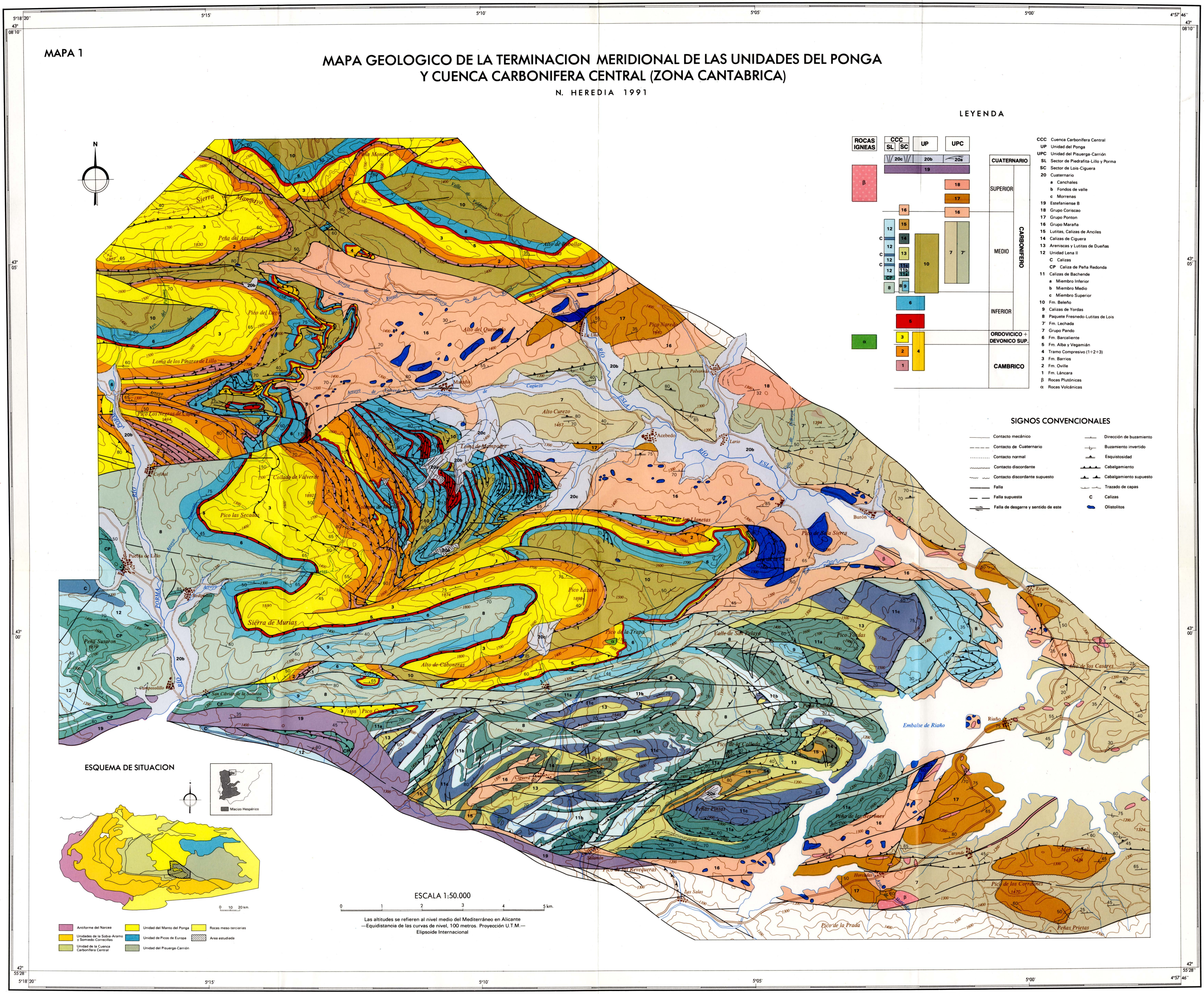
MAPA 1

MAPA GEOLOGICO DE LA TERMINACION MERIDIONAL DE LAS UNIDADES DEL PONGA Y CUENCA CARBONIFERA CENTRAL (ZONA CANTABRICA)

N. HEREDIA 1991



LEYENDA

- **CCC** Cuenca Carbonífera Central
- **UP** Unidad del Ponga
- **UPC** Unidad del Pisuerga-Carrión
- **SL** Sector de Piedrafita-Lillo y Porma
- **SC** Sector de Lois-Ciguera
- **20** Cuaternario
  - **a** Canchales
  - **b** Fondos de valle
  - **c** Morrenas
- **19** Estefaniense B
- **18** Grupo Coriscao
- **17** Grupo Ponton
- **16** Grupo Maraña
- **15** Lutitas, Calizas de Anciles
- **14** Calizas de Ciguera
- **13** Areniscas y Lutitas de Dueñas
- **12** Unidad Lena II
  - **C** Calizas
  - **CP** Caliza de Peña Redonda
- **11** Calizas de Bachende
  - **a** Miembro Inferior
  - **b** Miembro Medio
  - **c** Miembro Superior
- **10** Fm. Beleño
- **9** Calizas de Yordas
- **8** Paquete Fresnedo-Lutitas de Lois
- **7'** Fm. Lechada
- **7** Grupo Pando
- **6** Fm. Barcaliente
- **5** Fm. Alba y Vegamián
- **4** Tramo Compresivo (1+2+3)
- **3** Fm. Barrios
- **2** Fm. Oville
- **1** Fm. Láncara
- β Rocas Plutónicas
- α Rocas Volcánicas

SIGNOS CONVENCIONALES

Contacto mecánico	Dirección de buzamiento
Contacto de Cuaternario	Buzamiento invertido
Contacto normal	Esquistosidad
Contacto discordante	Cabalgamiento
Contacto discordante supuesto	Cabalgamiento supuesto
Falla	Trazado de capas
Falla supuesta	C Calizas
Falla de desgarre y sentido de este	Olistolitos

ESQUEMA DE SITUACION

Antiforme del Narcea	Unidad del Manto del Ponga	Rocas meso-terciarias
Unidades de la Sobia-Aramo y Somiedo-Correcillas	Unidad de Picos de Europa	Area estudiada
Unidad de la Cuenca Carbonífera Central	Unidad del Pisuerga-Carrión	

ESCALA 1:50.000

0 1 2 3 4 5 km.

Las altitudes se refieren al nivel medio del Mediterráneo en Alicante
—Equidistancia de las curvas de nivel, 100 metros. Proyección U.T.M.—
Elipsoide Internacional