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PROVISIONAL GEOLOGICAL MAP OF THE SOUTHERN CANTABRIAN MOUNTAINS (SPAIN)

The Valdeón — Liébana — Polaciones Area

BY

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ABSTRACT

The area is mainly covered by Carboniferous sediments. Only two Devonian structures are present. The Devonian yielded sufficient fossils from Eifelian up to Famennian but in the Carboniferous fossils are scarce. Permian and Triassic cover the area unconformably in the east. In the Carboniferous several formations of the Ruesga Group and the Yuso Group have been mapped. The base of the Yuso is marked by its basal conglomerate and its unconformable position upon the Ruesga.
The divergency of directions of contemporaneous major folds in the map area is controlled by fundamental faults. Two folding phases can be distinguished; Asturian folds with steep axial planes are superposed upon Sudetic recumbent folds.

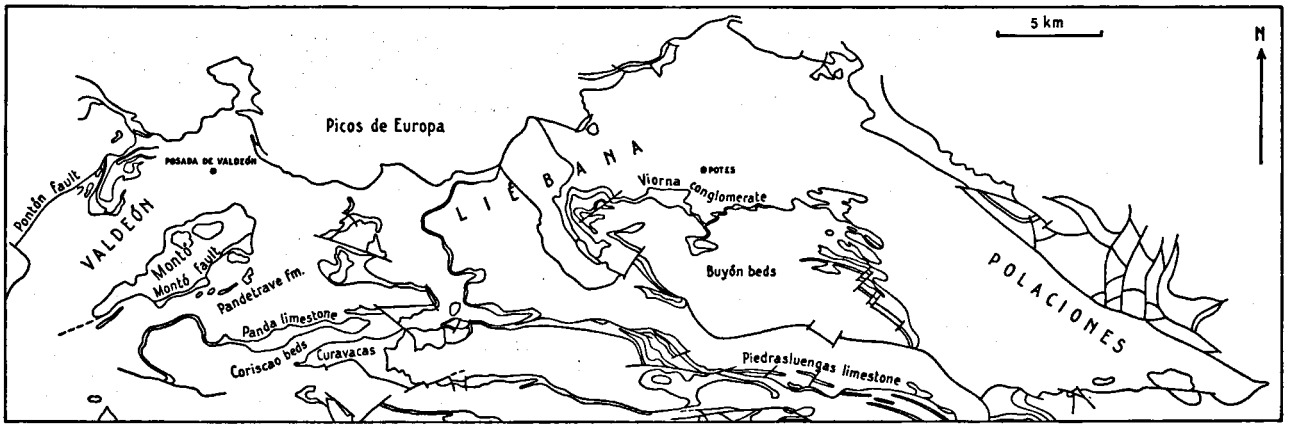

Fig. 1. Indexmap.

INTRODUCTION

The present area is an intrinsic part of the southern Cantabrian Mountains. We find here the continuation of the sediments and structures found in the Pisuerga area (de Sitter & Boschma, 1966, Nederlof, 1959, van Ginkel, 1965, several publications by Wagner and others), the Upper Carrion area (van Veen, 1965) and the Upper Yuso area (Savage, 1967). The area finds its natural boundary in its northern contact with the limestones of the Picos de Europa massif and in the east it is covered by unconformable Triassic and in the west the Ordovician quartzites mapped by Sjerp (1967) cut off the present structures.
The Valdeón-Liébana-Polaciones area has been mapped recently by Leiden students. Their work is recorded in unpublished reports. The Valdeón area has been studied by J. A. Kutterink, the Liébana area by W. K. Boehmer, R. W. Lanting and S. K. Miedema and the Polaciones area by K. Maas.
The exposed strata are of Devonian and Carboniferous age, with some probable Permian and Triassic in the Polaciones area.
Fossil content is very poor in the Carboniferous and absent in the Permian. The Devonian outcrops yielded conodonts and goniatites, which led to publications by van Adrichem Boogaert (1967), Kullmann (1963), Budinger and Kullmann (1964).
Van Adrichem Boogaert correlated the Devonian outcrops with the stratigraphy of the Upper Carrión River (van Veen, 1965). The mapping of the Carboniferous is based upon lithostratigraphic units only. Several mappable units can be recognized, of which the exposures are easily comparable with those in the rest of the southeastern part of the Cantabrian Mountains. Several formations of the Ruesga Group could be recognized. The black shales of the Vegamián Formation and the griottes of the Alba Formation are only present in the Valdeón area, as are the limestones of the Caliza de Montaña Formation.
In the Liébana and Polaciones areas the lowest part of the Carboniferous is represented by shale-greywacke deposits, comparable with equal developments of the Cervera Formation in the southeast (de Sitter & Boschma, 1966). On top of these follow unconformably conglomerate beds. These Viorna Conglomerate Beds are regarded as a lateral equivalent to at least a part of the Curavacas Formation. The character of these conglomerates and their unconformable position upon folded greywackes gives us the correlation with that basal formation of the Yuso Group (Koopmans,

1962). The Viorna Conglomerate Beds are followed by more greywackes and limestones conformably folded together. Unconformable Stephanian deposits have not been found, thus the presence of formations belonging to the Cea Group has not been established. K. Maas found well stratified deposits of volcanic character unconformably on top of the folded Carboniferous, and itself again unconformably covered by the Triassic. These deposits probably should be regarded as Permian. We hope to publish the results of his work in the near future.

THE STRATIGRAPHIC UNITS

Devonian

Two Devonian outcrops have been mapped, the Montó structure in the Valdeón area and a Devonian ridge in the Liébana area.

The Montó structure yielded conodonts from Eifelian up to Famennian age. The Devonian in the Liébana area represents only the upper part, as the oldest fossils found are of Famennian age (van Adrichem Boogaert, 1967).

Carboniferous

The lithology exists of shales and mudstones with greywackes, quartzites, conglomerates and limestones. As lateral grading of one unit into another is a common feature, units of unifying character are not easily distinguished. Some formations, however, still could be established.

YUSO GROUP

Pandetrave Turbidite Formation	? =	Valdeón Shale and Greywacke Formation
Lechada Clastic Formation	}	Panda Limestone Members Buyón Beds ≈ Coriscao Beds
Curavacas Conglomerate Formation	≈	Viorna Conglomerate Beds

RUESGA GROUP

Caliza de Montaña Limestone Formation (Picos de Europa)		Cervera Shale and Greywacke Formation (Liébana-Polaciones)
Alba Griotte Formation Vegamián Black Shale Formation	}	NW of Montó-fault only

The Vegamián Black Shale Formation. — These shales are only present in the Montó area. They have been mapped by Kutterink (unpublished report) and described by van Adrichem Boogaert (1967) who collected their conodonts.

The Alba Griotte and the Caliza de Montaña. — These are also present in the Montó area only. The reader is referred to van Adrichem Boogaert (1967). We have not mapped the limestones of the Picos de Europa, but it is evident that these limestones belong to the Caliza de Montaña Formation. When we compare their southern boundary with the Almonga structure west of Cervera de Pisuerga (Kanis, 1956) we see the same situation of Caliza de Montaña Limestones divided by a fault line from their contemporaneous greywackes of the Cervera Formation.

The Cervera Formation. — The Cervera Formation contains shales with greywackes and sandstones, a few reefoid limestones and several slumped conglomerate and sandstone lenses. Many limestone lenses also seem to have been slumped. Van Ginkel (1965) collected forams from the topmember, the Piedrasluengas Limestone Member.

Comparison with outcrops of the Cervera Formation in the southern Pisuerga area, and the unconformable position below the Curavacas Conglomerates confirm the correlation of the outcrops in this Liébana area with those in the Cervera region.

In the western Liébana the presence of the Viorna Conglomerates facilitates the mapping of the base of the Yuso Group, i.c. the top of the Ruesga. More to the east, the basal conglomerate disappears and the proper boundary is difficult to draw. In general the Cervera Formation contains less sandstone than the following formations of the Yuso Group. Where the basal conglomerate is absent, the unconformity is badly or not at all exposed. A difference in folding pattern, however, is evident. Thus Koopmans' (1962) argument of establishing two groups of formations, divided by a tectonic phase is still applicable in the present area.

The Viorna Conglomerate Beds. — These beds are correlated with the conglomerates of the Curavacas Formation. Apart from quartzite pebbles and limestone fragments, pieces of lydite are present. The conglomerates show a mudflow character and the pebbles often do not touch each other in their sandy mudstone matrix.

The Lechada Formation. — Several beds and members have been mapped, which belong to the Lechada Formation:
In the Liébana the Viorna Conglomerates are followed by *The Buyon Beds*, a sandy flysch sequence in which more conglomerate lenses occur. The majority of greywacke beds show turbidite features; several greywackes however are crossbedded from bottom to top and thick crossbedded sandstone beds also occur. In general these beds seem sandier than the deposits of the Cervera Formation.
In the eastern Liébana the Curavacas Conglomerate Beds are followed by the *Coriscao Beds*, which show an alternation of bedded and non bedded lithology. Limestone fragments from grit up to large pieces of reefs have slid into a mud environment, as have some quartz conglomerates and sandstones. Other fragmental limestones are bedded. At the top follows a bedded sequence of sandstones and shales.
The following *Panda Limestone Member* seems to cover conformably the top of these sandstones. This limestone has many reefknolls and is in places full of fossils. Forams have been collected by van Ginkel (1965). The top of this limestone is remarkable strongly eroded.

The Pandetrave Formation. — The Panda limestone is followed by crossbedded sandstones and sandy limestones in shale environment, upwards grading into the turbidites of the Pandetrave pass. More turbidites follow, and slumped limestones also reappear, intercalated with micaceous sandstones with fossil plant debris. At the top the Brañas Limestone has been slumped into black shales together with limestone breccias.

Valdeón Formation. — Due to the position of the Montó structure between the Brañas limestones and the deposits in the Valdeón area it is not yet clear whether the Valdeón Formation sits on top of the Pandetrave Formation or whether they are — partly — lateral equivalents. The formation contains shales and greywackes with sandstones and numerous conglomerate beds and lenses. Fossil plant debris is not uncommon in the sandstones and greywackes, but the remains are badly broken. Only at one exposure, near the fault contact with the Picos de Europa a few fossil leaves have been determined by van Amerom (pers. comm.). As the majority belongs to the genus *Callipteridium* a Stephanian age is probable.

Stephanian. — Unconformable Stephanian basins like those in the Leonides are not present in this area and anyhow the Carboniferous age of the deposits in this area is very poorly demonstrated due to lack of fossils. One outcrop in the Valdeón area at the foot of the Picos de Europa limestones seems to indicate a Stephanian age for the uppermost Yuso deposits. Presumably, like in the Casavegas section (Pisuerga area, de Sitter & Boschma, 1966), these Stephanian deposits follow conformably upon the Westphalian.

Permian
Permian volcanic deposits have been found by K. Maas below the Triassic cover in the Polaciones area. The results of his investigations on these will be published in the near future.

Triassic
The Triassic cover in the east of the area is the continuation of the same beds covering the Carboniferous in the Pisuerga area.

STRUCTURES

Introduction
In the Southern Cantabrian Mountains the general trend of the structures is E-W. Oblique directions, however, are also very common (de Sitter 1957, 1966). The Valdeón area, situated between the Pontón fault and the Montó fault is an example of such an oblique structure.
South and west of the Montó fault major structures are mainly E-W again. In the southeast of the map area, however, we see trends curve into the NW-SE Pisuerga direction. Another oblique structure is that of the Devonian quartzites in the Liébana area which also have a NW-SE direction.

The Pontón fault
The Devonian Montó Unit in the Valdeón area is dominated by quartzites. The associated limestones have been correlated with those of the Carrión area (van Adrichem Boogaert, 1967; van Veen, 1965) but they differ strongly from the Devonian sequence along the rivers Bernesga and Esla (Comte, 1959). Van Adrichem Boogaert gives details of the zoning of the Upper and Middle Devonian rocks of the Montó structure.
On the contrary, in the nearby Cuenca de Beleño (Julivert, 1960; Sjerp, 1967) Ordivician quartzites are only locally covered by Upper Devonian. The nearly total absence of Devonian in that area must be due to the Bretonnic uplift and erosion, in the same way as in the Leonides where the hiatus increases northward (de Sitter, 1962).
The Montó Unit, with more or less well developed Middle and Upper Devonian is separated from the Beleño area — void of Devonian — by a fault, which operated possibly before as well as during the Bretonnic phase. The role of this Pontón fault can be compared to that of the León line which separates a Leonian facies (Valsurvio dome, — San Martín — Ruesga area) from a Palentian facies (Upper Carrión — Cardaño de Arriba — Montó area).
The Pontón fault did not influence the distribution of the Alba Griotte and the Caliza de Montaña, as these are found in the Cuenca de Beleño as well as in the Montó Unit. Later reactivation of the Pontón fault is demonstrated by the different facies of the Yuso sediments on both sides, which contain several limestones in the Beleño area but no thick conglom-

erates such as have been found in the Valdeón area.

The Montó — Picos de Europa fault

About parallel to the Pontón fault runs the Montó fault, the southeastern boundary of the Montó unit, and its continuation along the southeastern margin of the Picos de Europa. Along this fault we find the transition-zone between — shallow — limestone development and — deeper — flysch of the Cervera Formation. Due to turbidity currents in the flysch area, limestones could not develop. At the other side of the fault line limestones developed in an area with clean water, where turbidites did not reach.

The active role of the Montó fault is apparent during Viséan and Namurian times; the distribution of the subsequent Yuso sediments, however, is not obviously controlled by that fault.

Thus these SW-NE faults are limits of areas with distinctive facies and it seems clear that the distribution must have been controlled by movements along these faults during the deposition of the sediments.

In the Valdeón area folds developed between these two SW-NE faults, and parallel to them. The explanation of such a feature has been given by de Sitter (1957) for the NW-SE trends in the Pisuerga area, where also between major faults the common N-S directed orogenic stress is diverted into a direction parallel to those faults.

The general structural trend in the Liébana area is E-W, but divergences occur.

The Devonian quartzites of the Collaín ridge have a NW-SE trend and in the neighbourhood of these quartzites the structures in the unconformable Carboniferous tend to deviate parallel to that direction. Towards the Pisuerga area structural trends also curve into the NW-SE direction of that area. Thus the structural lines which control the structures of the Pisuerga area apparently continue, however less pronounced, into the Liébana.

Folding phases

The unconformity at the base of the Curavacas Conglomerates is apparent in several exposures. This is either demonstrated by the oblique postition of the conglomerates on older rocks, or by folds of older rocks being cut off by the conglomerate. The unconformity marks the base of the Yuso Group.

The older folds developed during the Sudetic folding phase. North and south of Potes we find asymmetric folds with long flat northern flanks and short steep southern flanks. Axes are roughly E-W. Towards the east these folds become recumbent with equal limbs. Large overturned limbs are a common feature.

More to the south, however, in the Espinama-Barago-Vendejo zone, folds of the Sudetic phase have not been determined.

In the Liébana area the Sudetic folds have been refolded by zigzag folds with steep axial planes, which themselves often again show curved axial planes. Similar folds are common in the Yuso of the Liébana and in the Ruesga of the Espinama-Barago-Vendejo zone.

There are obviously two successsive types of folds, one asymmetric or recumbent, but only locally developed and cut off by the Yuso, and a second type of smaller steep zigzag folds, affecting a much larger area of the Ruesga and also the Yuso. The curving of the axial planes of the second-phase folds is not regarded to be the result of still another phase of folding.

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