TRABAJOS DE GEOLOGÍA, 4, Fac. Ci. Univ. Oviedo
«The Carboniferous of Northwest Spain»
pp. 365-372, text-figs. 1-5, pl. 1

CHARACTERISTICS OF THE SEDIMENTATION OF EARLY WESTPHALIAN D ROCKS NEAR THE NORTH-WESTERN BORDER OF THE CENTRAL ASTURIAN COALFIELD (CORDILLERA CANTABRICA)

J. PELLO* & I. CORRALES**

ABSTRACT

The Olloniego Limestone Formation, of lower to middle Westphalian D age, and up to 800-1000 metres thick, wedges out laterally within a few kilometres. This sequence consists of poorly sorted limestone conglomerates, sandstones, lutites and locally developed coal seams and limestone beds. The limestone conglomerates contain boulders of the Rañeces Formation (Devonian) which only crops out west of the central Asturian coalfield. A sedimentological analysis of the conglomerates shows that the transport of boulders and pebbles experienced notable changes in energy, as a result of lateral contributions, as follows from the size variation of boulders and pebbles. The steepness of the sedimentary basin increased as sedimentation progressed.

The deposits accumulating in the more steeply inclined areas are represented by limestone beds with marine fauna. The general environment may have been deltaic, with the principal current direction coming from the west in the central part of the area studied (between La Mortera and Malpica).

RESUMEN

La formación de conglomerados calcáreos de Olloniego, de edad Westfaliense D inferior a medio, es una potente sucesión (800-1.000 m de espesor máximo) que se acuña lateralmente en unos pocos kms. Está constituída por conglomerados calcáreos mal calibrados, areniscas, lutitas y, localmente, algunas capas de carbón y calizas. Los niveles de conglomerados contienen, entre otros elementos, cantos de caliza de la Formación Rañeces (Devónico inferior), que solamente aflora al W de la Cuenca Carbonífera Central de Asturias.

El estudio sedimentológico realizado en los conglomerados revela que el medio de transporte sufrió, a lo largo del depósito, importantes variaciones en su energía, debido a estar influenciado por aportes laterales, cuya existencia se deduce de las variaciones en la distribución granulométrica de los cantos. La pendiente del medio sedimentario sufrió un aumento a medida que progresaba la sedimentación.

Las intercalaciones calcáreas, con fauna marina, muestran las características de depósitos acumulados en fondos inclinados.

De todo ello se deduce un medio de sedimentación deltaico, en el que la corriente principal de aporte entraba, con una componente occidental, por la zona central de la formación (entre las localidades de La Mortera y Malpica).

* Departamento de Geomorfología y Geotectónica, Facultad de Ciencias, Universidad de Oviedo, Spain.
** Departamento de Estratigrafía, Facultad de Ciencias, Universidad de Salamanca, Spain.

INTRODUCTION

The north-western margin of the central Asturian coalfield is characterized by overthrusting Devonian sandstones and Namurian limestones («caliza de montaña») lying on Westphalian D strata (text-fig. 1). From the township of Mieres to the north-west the stratigraphic succession is younging within Upper Westphalian strata which are constituted by six formations, viz:

6. Loredo Formation, characterized by marine limestones, lutites, sandstones and some non-workable coals. Maximum visible thickness 150 metres, and limited upwards by the north-western boundary thrust of the central Asturian coalfield.

5. Ablanedo Coal-Measure Formation, with sandstones, lutites, clays and occasional coal seams which were worked in the past. This formation, *ca.* 230-500 metres thick (as much as is visible), is generally found below the thrust masses of Devonian sandstone and Namurian limestone on the edge of the coalfield.

4. Olloniego Limestone Conglomerate Formation, with (a) poorly sorted conglomerates with boulders and pebbles of Devonian and Carboniferous limestones and a minor proportion of sandstones and quartzites in a calcarenitic matrix; (b) sandstones, lutites, occasional limestones and coal seams. Maximum thickness *ca.* 800-1,000 metres.

3. Esperanza Coal-Measure Formation, with sandstones, lutites, a few quartzite conglomerate horizons and occasional coal seams, some of which have been worked. Maximum thickness *ca.* 300 m.

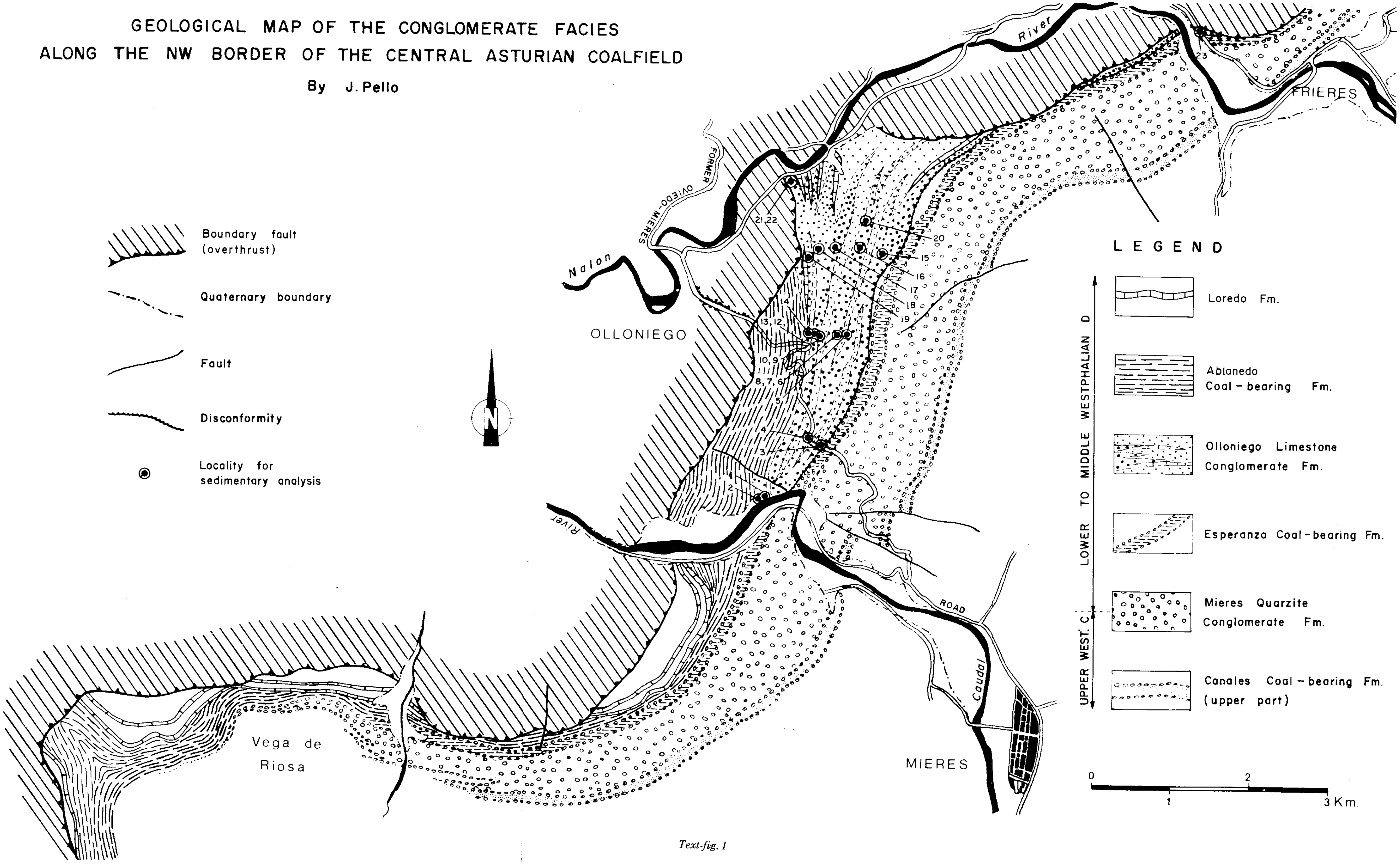
2. Mieres Quartzite Conglomerate Formation, consisting of poorly sorted quartzite boulders in a quartz-arenitic matrix. Maximum thickness 700 m.

1. Canales Coal-Measure Formation, consisting of coal seams, seat-earths and roof shales in a partly marine succession which, in its higher part, contains also quartzite conglomerate beds. The coal seams of this formation are still worked at present. Maximum thickness *ca.* 800 metres.

From the Mieres Conglomerate Formation upwards the age of these deposits is Westphalian D (Jongmans & Wagner 1957; Wagner 1971). The upper part of the Canales Formation and the quartzite conglomerates of Mieres have been studied sedimentologically by Corrales, Carballeira & Manjón (1971). In the present paper the Olloniego Limestone Conglomerate Formation, of lower to middle Westphalian D age, is studied in particular.

OLLONIEGO FORMATION

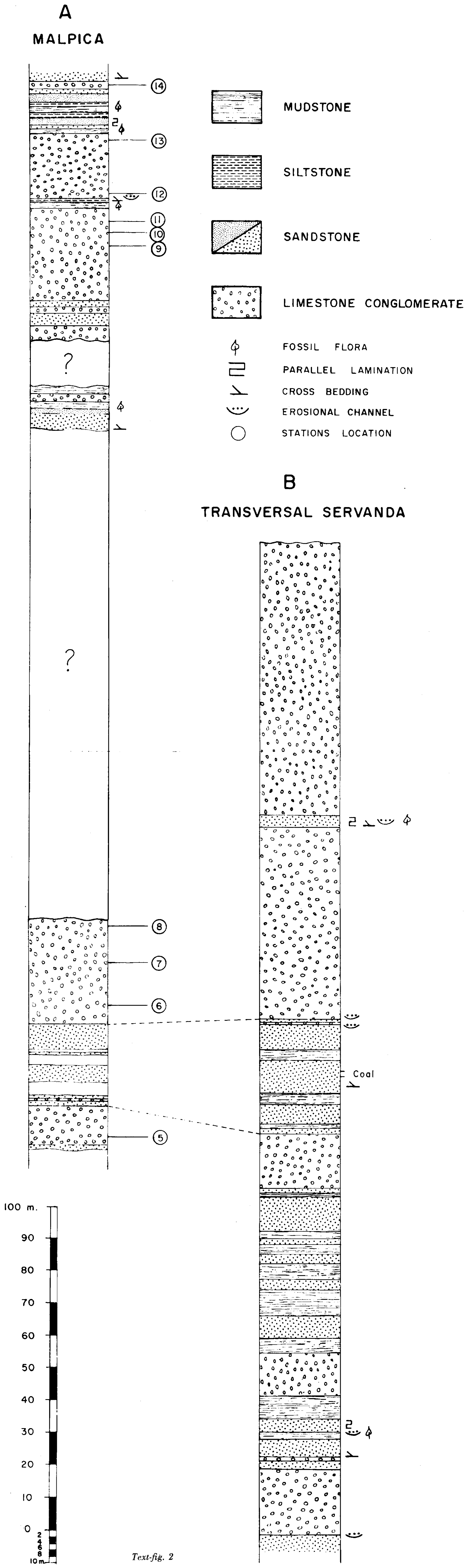
Between the limestone conglomerate formation of Olloniego and the Esperanza Formation an erosional interval of short duration forms a disconformity which, as a result of relatively poor exposure, can only be proved as a mappable unconformity (Pello 1968). The erosional interval is also evident in the sedimentary characteristics



GEOLOGICAL MAP OF THE CONGLOMERATE FACIES
ALONG THE NW BORDER OF THE CENTRAL ASTURIAN COALFIELD
By J. Pello
Boundary fault (overthrust)
Quaternary boundary
Fault
Disconformity
Locality for sedimentary analysis
N
Nalon
River
FORMER OVIEDO-MIERES
OLLONIEGO
FRIERES
Vega de Riosa
MIERES
Caudal
ROAD
LEGEND
Loredo Fm.
Ablanedo Coal-bearing Fm.
Olloniego Limestone Conglomerate Fm.
Esperanza Coal-bearing Fm.
Mieres Quarzite Conglomerate Fm.
Canales Coal-bearing Fm. (upper part)
LOWER TO MIDDLE WESTPHALIAN D
UPPER WEST. C
0 1 2 3 Km.

Text-fig. 1

STRATIGRAPHIC SECTION OF THE OLLONIEGO LIMESTONE CONGLOMERATE FORMATION



Text-fig. 2

of the Olloniego Formation, which shows sandstone and limestone boulders of Carboniferous age as well as bits of coal within the conglomerate beds.

Text-fig. 2 shows the lithological successions found in the vicinity of Malpica, near Olloniego. One of the sections (Column A) was measured in the cutting of the old road leading from Malpica to the Padrún section of the Mieres-Oviedo road and was completed by the exposures found along the track from Olloniego to the new colliery of HUNOSA. The second section (column B) was obtained in the Cross-Cut Servanda, of the San José Colliery. This section supplements the first one by providing a more complete lower part.

The sequence consists of: (a) conglomerates formed mainly by limestone boulders and pebbles derived from various horizons in the Devonian and the Carboniferous («caliza de montaña», «griotte», limestones of the Rañeces Formation, etc.), but also containing boulders of Carboniferous sandstone and quartzite, Ordovician quartzite and, more rarely, coal fragments; (b) fine- to coarse-grained sandstones, generally with some calcareous component and matrix; as represented in text-fig. 2, these sandstones show the presence of sedimentary structures such as cross bedding of theta and, possibly, also of zeta types (ALLEN 1963) (see pl. 1A), and parallel lamination produced by bedding planes with carbonaceous debris; (c) siltstones and very silty mudstones; (d) argillaceous lutites, sometimes containing plant fossils; occasional coal seams which, in view of their small thickness, have not been represented in the stratigraphic columns. Where sandstone or conglomerate horizons rest on lutites, siltstones and fine-grained sandstones, scours are quite common.

Well preserved floras have been collected from the upper part of Column A. These are figured and described by R. H. WAGNER 1971 (loc. 14 - Malpica).

The total thickness of the succession in this locality is of the order of 450 metres. Northwards an appreciable increase in thickness is observed, up to 800-1,000 metres, with a progressive increase in the more finely detrital deposits and limestones. To the north-east, the thrust fault which determines the boundary of the coalfield only permits a few metres of the basal part of the conglomerate formation to be observed. To the south the Olloniego Formation disappears with a gradual diminishing of the thickness of the entire complex of conglomeratic deposits which, however, seem to be more evenly developed here than in the northern part of the area.

North of Pico Castillo lenticular limestones, with marine fauna, are encountered in association with the conglomerates, and particularly in the basal and upper parts of the formation. The faunas are composed of foraminifera, ostracodes, algae, bryozoa and brachiopods, above all. A limestone sample collected in the vicinity of Santianes shows the characteristics of lime mud accumulated on sloping areas. Plate 1B shows small erosion pockets (a). These characteristics agree with deposits formed in the marginal zone of a fan-shaped area of dispersion of sediment particles transported by weak currents (decantation of particles which remain dispersed among a mass of lime mud). Only sporadically is there question of stronger currents (passage of horizontal to inclined particles) (b). These limestone intercalations may be due to a change in the direction of currents transporting the terrigenous material forming sandstones and conglomerates.

TRANSPORT CHARACTERISTICS

In order to determine the characteristics of the transporting medium which produced the conglomerates, various measurements were made in 23 localities (text-fig. 1). In each locality the major apparent axes of 100 pebbles and boulders were measured. The graphs obtained by representing these data on probability paper show a change in slope, or deviation from the ideal curve for the frequency values, which vary with the different stations. This change in slope of the curve should be interpreted as the result of local supply, generally larger elements being incorporated with the deposit formed by the principal current.

The frequency values with which this change in slope commences, are shown in text-fig. 4 (stations arranged in upward sequence). It will be observed that the variation in frequency value is not gradual but, on the contrary, markedly irregular. Occasionally, high frequency values —representing a minimum of local additions—, are followed by low values— showing a maximum influence of immature local elements—, and vice versa.

The first mentioned case should be recognizable as an erosional interval between localities sampled. The general paucity of good outcrops makes it difficult to observe such intervals. However, the section measured in the Cross-Cut Servanda shows a number of channels between stations 5 and 6 (text-fig. 5). This erosion level is probably continued between stations 4 and 1, and 15 and 16, and would pass above locality 23 (text-fig. 4). Another one may be situated between stations 19 and 21. A more detailed study may well reveal the presence of further erosional intervals.

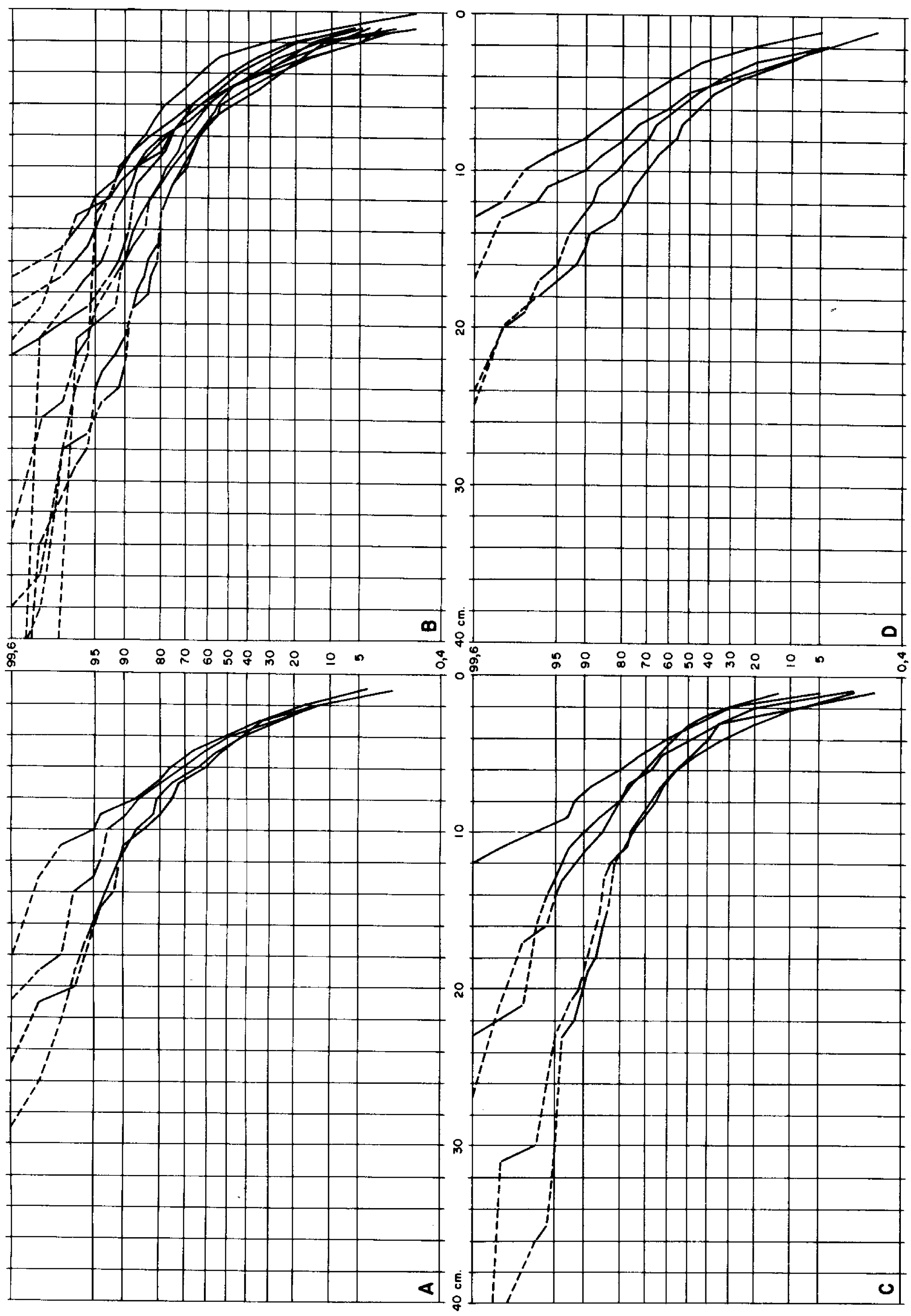
The second case, i.e. when a period of important local additions follows upon one with a minimal influence of local elements, indicates a loss of energy in the transporting medium, which would consequently move pebbles of smaller dimensions. This is what may have happened between stations 1 and 2, 9 and 10, and between localities 18 and 19. As can be observed in Table 1, these changes are accompanied, in effect, by a decrease in the values of all parametres and of the standard deviation.

The main influence of local elements, i.e. where the lowest frequency values appear among those which show a change in slope of curve, is found among the localities of La Mortera and Malpica (text-fig. 1, stations 15, 16, 17, 21, 6, 7, 8, and 9). It may, therefore, be assumed that the main transporting current entered the area of sedimentation in this region.

Table 1 shows the values obtained for 16 %, mean, 84 %, standard deviation and 50 % of the diameters of boulders and pebbles in each station. Among these, the ones corresponding to the first three parametres have been represented in text-fig. 5. The resulting curves show some variations which reflect changes in the sorting of boulders and pebbles or, correspondingly, of changes in current energy. Generally, it appears that the transporting medium commenced with a relatively low energy, which increased notably in the middle part of the formation, and which diminished again in the highest part. Understandably, the periods of maximum energy of current transport coincide with those of maximum influence of local elements.

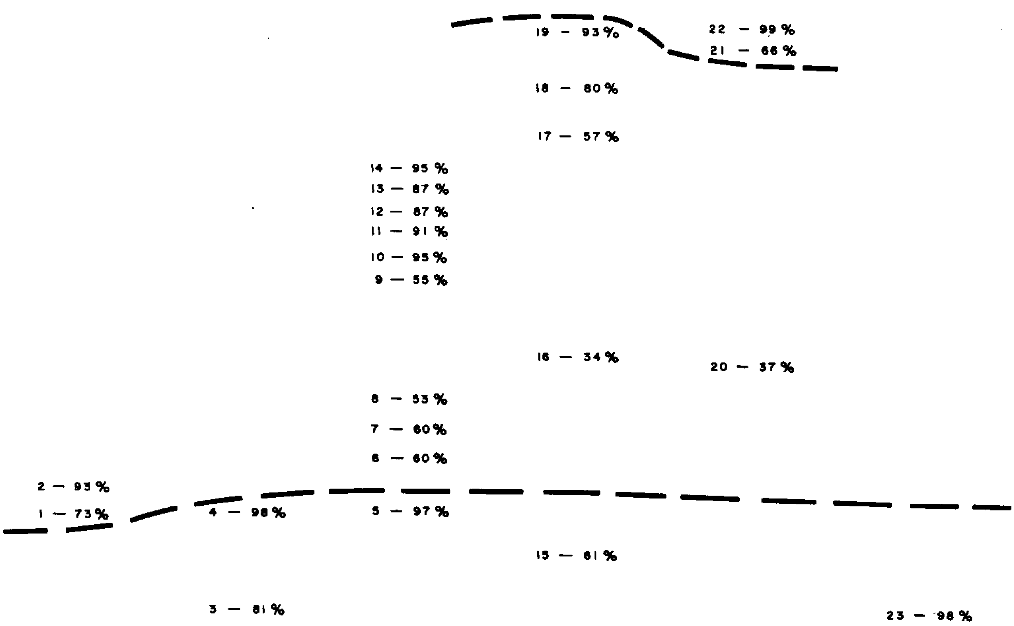
→

Text-fig. 3.—Cumulative curve of the major apparent axes of limestone boulders and pebbles. A: Stations 1 to 4. B: 5 to 14. C: 15 to 19. D: 20 to 23.



A
B
C
D
0
10
20
30
40 cm.
99,6
95
90
80
70
60
50
40
30
20
10
5
0,4

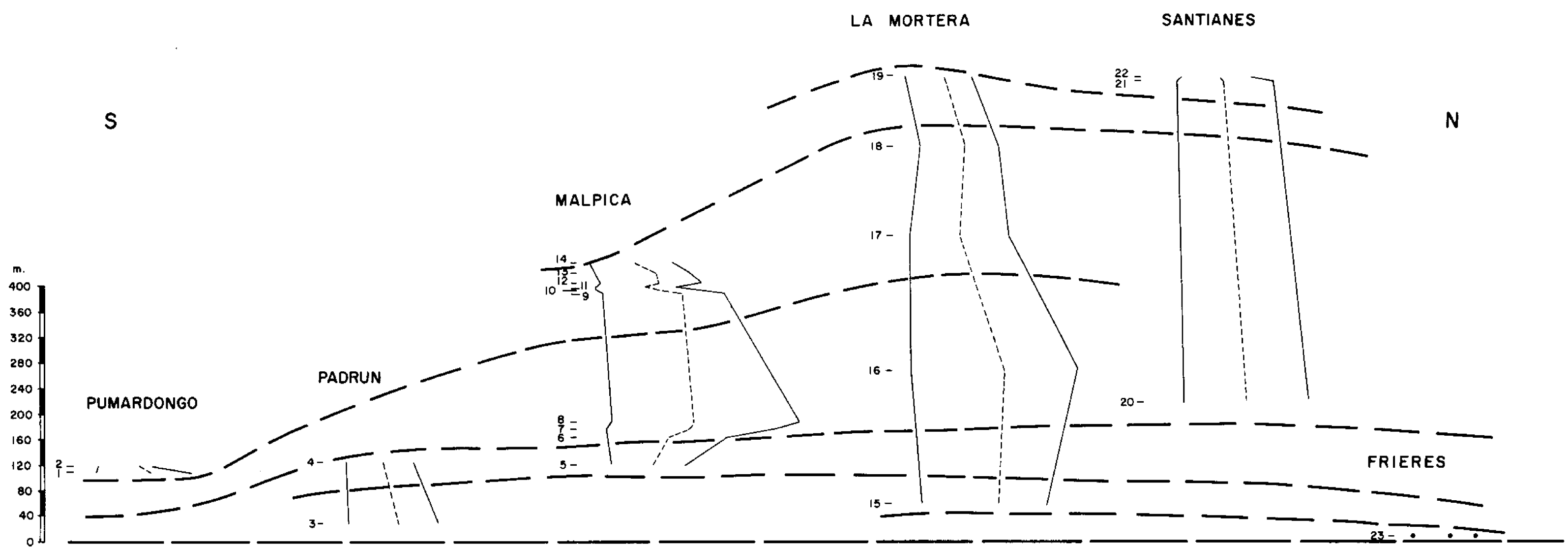
The field mapping of various horizons, including the erosional intervals (text-fig. 5), has shown that the sedimentation followed at first practically horizontal surfaces. Later, however, the deposition took place on sloping surfaces (which are, of course, less strongly inclined than the surface drawn in text-fig. 5 in which the horizontal distances are shortened). This fact, together with the characteristics of the intercalated limestones, indicate that the limestone conglomerates of the Olloniego Formation were formed as deltaic deposits, a conclusion which would not have been obvious if only the basal strata had been studied. The more marine part of this delta may have been situated in the northern part of the area studied, since the limestone intercalations occur in that part of the region.



Text-fig. 4.—Frequency values for the changes in the slope of curves. Dashed lines represent erosional surfaces deduced from variations in these values.

The presence of limestone pebbles derived from the Rañeces complex, which is a formation of Devonian age, found only west of the central Asturian coalfield, shows that the principal current came from a western direction.

The limestone conglomerates of the Olloniego Formation indicate an increase in the energy potential of the source area, and this may be due to either orogenic or epeirogenic causes.



Text-fig. 5.—Values of 16 %, mean and 84 % (continuous, dashed and continuous lines respectively) in vertical columns for the stations in each locality, as arranged in upward sequence. Coarse dashed lines represent limestone conglomerate horizons as deduced from mapping, and the erosional surfaces of text-fig. 4. A horizontal base is assumed, and this has been drawn as a more continuous line.

TABLE 1

Locality number	16 %	84 %	Mean	Standard deviation	50 %
1	2.2	9.7	6.50	3.75	4.6
2	2.3	6.6	5.65	2.15	4.2
3	2.2	9.4	6.25	3.60	4.6
4	2.0	7.4	5.06	2.70	3.9
5	3.0	8.9	6.38	2.95	5.0
6	2.6	12.3	7.65	4.85	5.0
7	2.7	16.0	9.31	6.69	6.2
8	3.1	18.0	9.58	7.45	5.7
9	2.3	12.0	8.69	4.85	5.2
10	1.8	9.5	6.73	3.85	4.6
11	1.7	8.2	5.66	3.25	4.2
12	2.2	10.2	6.86	4.00	5.6
13	1.7	9.3	6.61	3.80	4.6
14	1.3	7.8	4.79	3.25	2.8
15	2.7	12.6	8.80	4.95	7.5
16	1.8	15.0	9.12	6.60	5.3
17	1.6	9.5	5.54	3.95	3.1
18	2.4	8.6	5.92	3.10	4.1
19	1.2	6.4	4.31	2.60	3.3
20	3.4	13.2	8.44	4.90	6.6
21	2.8	10.4	6.51	3.80	5.4
22	3.2	8.6	6.20	2.70	5.0
23	1.7	6.6	4.55	2.45	3.4

REFERENCES

ALLEN, J. R. L. (1963).—The classification of cross-stratified units, with notes on their origin. *Sedimentology*, 2, 2, pp. 93-114, figs. 1-4, Tables I-II.

CORRALES, I., CARBALLEIRA, J. & MANJÓN, M. (1971).—Los conglomerados del borde NW de la Cuenca Carbonífera Central de Asturias y la sucesión productiva inferior. *Trabajos de Geología, Fac. Ci. Univ. Oviedo*, 3, pp. 75-86, figs. 1-7.

JONGMANS, W. J. & WAGNER, R. H. (1957).—Apuntes para el estudio geológico de la zona hullera de Riosa (Cuenca Central de Asturias). *Estudios Geol.*, XIII, 33, pp. 7-26, figs. 1-2, lám. II.

PELLO, J. (1968).—Nuevos datos sobre la estratigrafía y tectónica del borde NO. de la cuenca carbonífera central de Asturias. *Bol. Geol. y Min.*, LXXIX-II, pp. 115-129, figs I-VIII, map. geol.

POTTER, P. E. (1967).—Sand bodies and sedimentary environments: a review. *Bull. Amer. Ass. Petr. Geol.*, 51, 3, pp. 337-365, figs. 1-12, tables 1-6.

TWENHOFEL, W. H. (1947).—The environmental significance of conglomerates. *Jl. Sed. Petrol.*, 17, 3, pp. 119-128.

WAGNER, R. H. (1971).—The Westphalian D floras of the Olloniego and Esperanza formations in the Central Asturian Coalfield. *Trabajos de Geología, Fac. Ci. Univ. Oviedo*, 4, pp. 461-505, text-fig. 1, pls. 1-17.

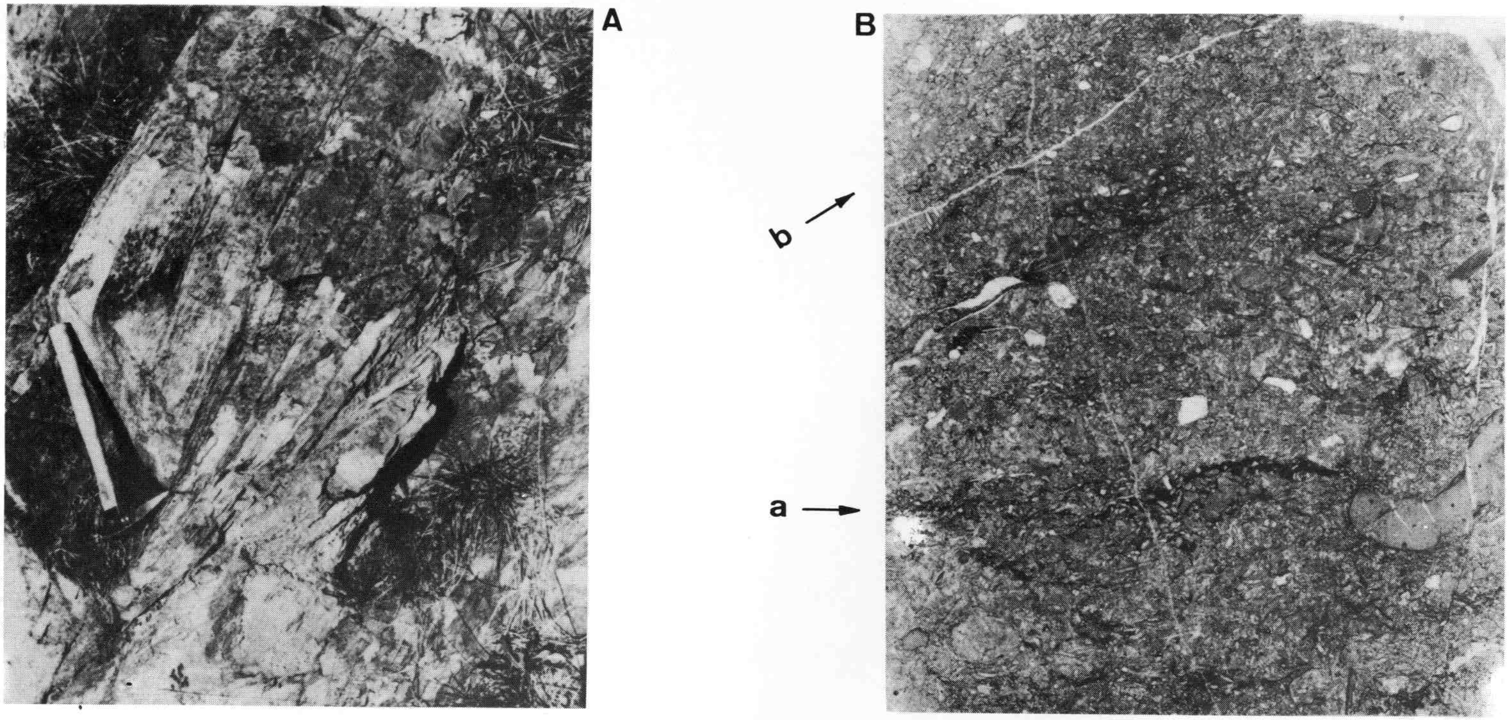


Fig. A. Cross bedding in sandstones of the upper part of the column of Malpica (text-fig. 2).

Fig. B. Erosion hollows (a); inclined position of clasts indicating an increase in the intensity of the current (b); and marine fauna in the limestones.