2.º A partir del punto A se traza una paralela a la escala inclinada cuya longitud corresponda en dicha escala a la precisión que deseemos. (Punto B).

3.º A partir del punto B se traza una horizontal y en su intersección con la escala vertical leemos el número de mediciones necesarias.

Un hecho que conviene indicar es que la dispersión de los valores del exponente de la ecuación de Kick-Meyer y su coeficiente de correlación son más independientes del número de medidas al intervenir en su cálculo los valores correspondientes a las diversas cargas, mientras que el efecto del valor de la dureza influye en mayor grado aunque manteniéndose dentro de límites aceptables.

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C. T. Baldwin (*).—THE STRATIGRAPHY OF THE CABOS SERIES IN THE SECTION BETWEEN CADAVEDO AND LUARCA, PROVINCE OF OVIEDO, N. W. SPAIN.

The Cambro-Ordovician aged Cabos Series in Asturias is composed of over 4.0 km of shallow marine clastic sediments. Due to the near absence of faunal information from these rocks, both stratigraphic subdivisions and correlations as well as palaeoenvironmental interpretations have been largely neglected. FARBER & JARITZ (1964) and JARITZ & WALTER (1970) considered some of the sedimentological aspects of the Cabos Series but restricted their stratigraphic discussion to correlations of local lithostratigraphic data available at the time and proposed preliminary ages for some parts of the Series. Most workers agree on a Middle Cambrian age for the shales immediately below the base of the Cabos Series (FARBER & JARITZ, 1964; RUIZ, 1971; MARCOS, 1973) and a Llanvirn (Middle Ordovician) age for the black shales above.

Thus, the boundaries of the Arenig, Tremadoc and Upper and Middle Cambrian could all be within the unfossiliferous clastic Cabos Series.

While the Cabos Series contains few diagnostic fossils, much useful stratigraphic information can ben derived from the morphology of contained tracks and trails. In this context, some of the trilobite trace fossils such as *Cruziana* (=trilobite furrows) and *Rusophycus* (=trilobite resting traces) are available and fairly sophisticated ichnostratigraphies have been developed in the United Kingdom (CRIMES, 1975), Europe and North America (SEILACHER, 1970).

Stratigraphic levels of trilobite trace fossils.—The positions of the various trace fossils described are shown on the continuously logged section (Fig. 1).

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C. semiplicata is present from near the base of the section to 3300 m, where it occurs with all three members of the Rugosa Group. *C. rugosa* occurs at and above 3300 m and apart from the one occurrence *C. rugosa* and *C. semiplicata* are mutually exclusive. *C. furcifera* and *C. goldfussi* extend to a level lower than *C. rugosa* and overlap with *C. semiplicata*. *C. furcifera* is absent below 2875 m.

Rusophycus Form A occurs intermittently throughout most of the range of *C. semiplicata*, but is absent above 2600 m. Form B appears above Form A, but within the zone of *C. semiplicata* and *C. rugosa*. The new Form, Form E, occurs at the junction between Forms A and B.

Monomorphichnus and *Dimorphichnus* reinforce the separation of *Cruziana* species, multi-digited forms of both these species only being associated with members of the Rugosa Group (i. e. above 2800 m). Due to the problems of preservation and ethological variability of production only the maximum numbers of digits indicated for each level may have stratigraphic meaning. Low digit numbers (two's and three's) coexist with high (sixe's and seven's) throughout the whole of the upper half of the section, but the sudden increase at 2900 m correlates well with the first appearance fo *C. furcifera*.

The forms of *Cruziana* transitional between the Rugosa Group and *C. semiplicata* appear at 2750 m and are absent above 3300 m, but the relatively small numbers of specimens do not permit accurate sub-division of this zone. *C. tortworthi* and *C. breadstoni* are absent from the section, but three specimens at 2887 m, 2913 m and 3175 m suggest the form of *C. tortworthi* but lack the pronounced angular claw impressions.

Stratigraphic division of the Cabos Series.—If circularity is to be avoided, strict adherence to already established trace fossil stratigraphies for areas other than under discussion must form the basis of stratigraphic subdivisions.

Two zones may be identified as the first stage of the stratigraphic subdivision (Fig. 1). At 3300 m (approximately the middle of Playa Ferreiro, east of Cabo Busto) *C. semiplicata* disappears and *C. rugosa* appears. CRIMES (1970, p. 112) indicates that *C. rugosa* is present in «very low Arenig» rocks at Trwyn Llwyd, south Wales, whereas *C. semiplicata* is absent. Consequently in Spain, it seems that *C. semiplicata* and *C. rugosa* almost coexist at one level (viz. *c.* 3300 m), so that in conformity with the British stratigraphy it appears most likely that the base of the Arenig must be above the highest *C. semiplicata*, possibly at approximately 3300 m where thick silts and muds overlie a 25 m thick-bedded quartzite.

Immediately below the suggested lower Arenig boundary is a 600 m thick zone with mixed ichnofaunas, including species which display elements of Cambrian and Ordovician species (i. e. *C. semiplicata*, *C. furcifera* and *C. goldfussi*). CRIMES (1975) described from the faunally dated Tremadocian rocks of Gloucestershire new species of *Cruziana* which appear to indicate Upper Cambrian/Arenig transitions of appendage morphology and particularly furrowing techniques. This work suggests *C. furcifera* has a range from Upper Tremadoc to Arenig, whereas the transitional species, *C. breadstoni* and *C. tortworthi*, are probably restricted to the Tremadoc, possibly only the lower division. Data from the Upper Tremadoc, however, is scant. *C. breadstoni* and *C. tortworthi* are not present in the Cabos Series, but the ichnofauna from

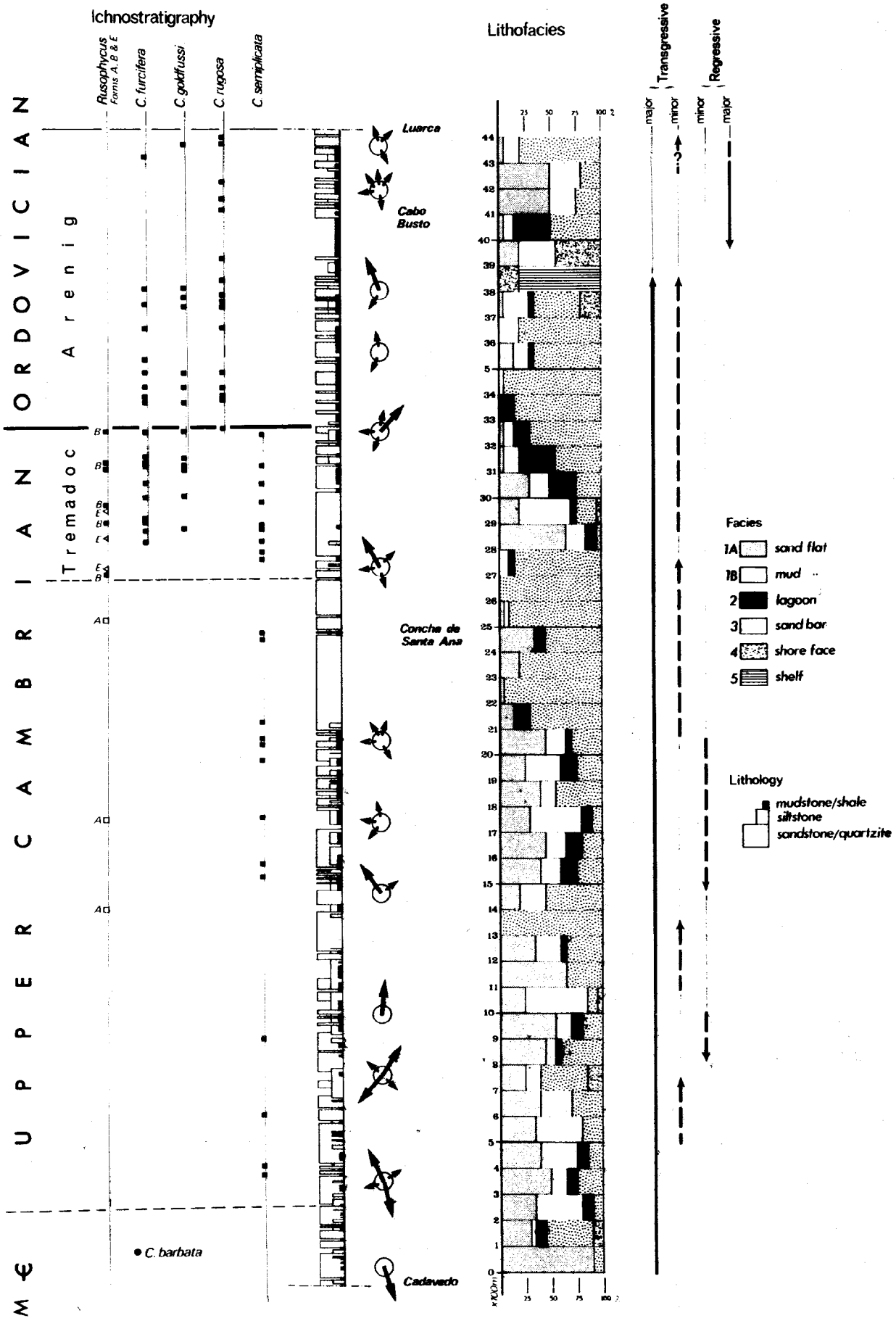

Fig. 1.—Ichnostratigraphic subdivision of the Cabos Series. The boundaries between the Middle and Upper Cambrian and the boundary at the base of the Tremadoc are equivocal. The Cambro-Ordovician boundary is relatively certain. Lithological and facies distributions are summarised. The principal palaeocurrents are shown with both major modes (large arrows) and minor modes (small arrows) included. Details of the lithofacies are shown in Fig. 2.

the beds above 2800 m (western side of unnamed bay, west of Concha Santa Ana) with *C. semiplicata*, *C. furcifera*, *C. goldfussi* and *Rusophycus* Form B, conforms with some elements of Upper Tremadoc ichnofaunas (cf. CRIMES, 1975, Table 1). The immediately underlying 100 m with *C. semiplicata* and *Rusophycus* Form B and Form E may be Lower Tremadoc (Fig. 1). Subdivisions of these Tremadoc (?) rocks are extremely tentative at this stage —further trace fossil data being required from faunally controlled sections elsewhere. However, the transitional nature of the complete 600 m unit is less equivocal and the proposed Tremadoc age appears reasonable.

Below 2800 m, the ichnofauna is restricted to *C. semiplicata* and *Rusophycus* Form A, both characteristic of Upper Cambrian (=sub-Tremadoc) strata (CRIMES, 1970, RADWANSKI & RONIEWICZ, 1963).

The preservation of trace fossils within the Upper Cambrian permits no sure subdivision of the lower 2800 m of the section. The beds immediately below the base of the Cabos Series (=Artedo Schichten, FARBER & JARITZ, 1964) are faunally dated as high Middle Cambrian (FARBER & JARITZ, *op. cit.)*, and the lower few metres of the Cabos Series (=Churin Schichten, FARBER & JARITZ, *op. cit.*) appear, on the basis of *C. barbata* (SEILACHER, 1970), to be of similar age.

No ichnofaunal change was noted during the detailed recording of the section which would permit the identification of the Upper and Middle Cambrian boundaries, and this aspect of the stratigraphy must remain unresolved until further material can be collected from associated sections.

Lithostratigraphy.—The sedimentology of the Cabos Series in the Cadavedo-Luarca section is extremely complex and a summary of the contained lithofacies and their distribution provides the only viable method of general description of the Series. The characteristic sedimentary structures of each facies are shown in Figure 2 and the distribution of facies within the Series is shown in Figure 1. Petrographic data on the Series is scant and requires further detailed investigation.

Five lithofacies are proposed. Each one reflects both bathymetric position and also variations in sediment type. The five facies reflect a range of sub-environments within an extensive shelf sea. The facies vary in position from intertidal shore line (Facies 1 and 2), to tidal off-shore bars (Facies 3), out to shore face (Facies 4) and open shelf (Facies 5).

Facies distribution.—The distribution of the five facies is shown in Figure 2.

The section contains a predominance of tidal flat facies in the lower half of the section with a gradual increase in off-shore bar and associated lagoonal facies in the middle of the section (*c.* 2200-3100 m level). These gradually pass upwards into increasingly distal facies characterised by shore face and shelf facies at approximately the 3000 m to 4000 m levels. This part of the section therefore constitutes a complexly fining-up sequence composed of an inter mixing of numerous transgressive and regressive couplets which form a major transgressive phase in the evolution of the Asturian Arc basin.

Above the offshore and shelf facies, distal sand bar and lagoonal facies initially predominate but give way in the succeeding 500 m to dominantly tidal flat facies including mud, mixed and sand dominated facies. Thus the upper 600 to 700 m of

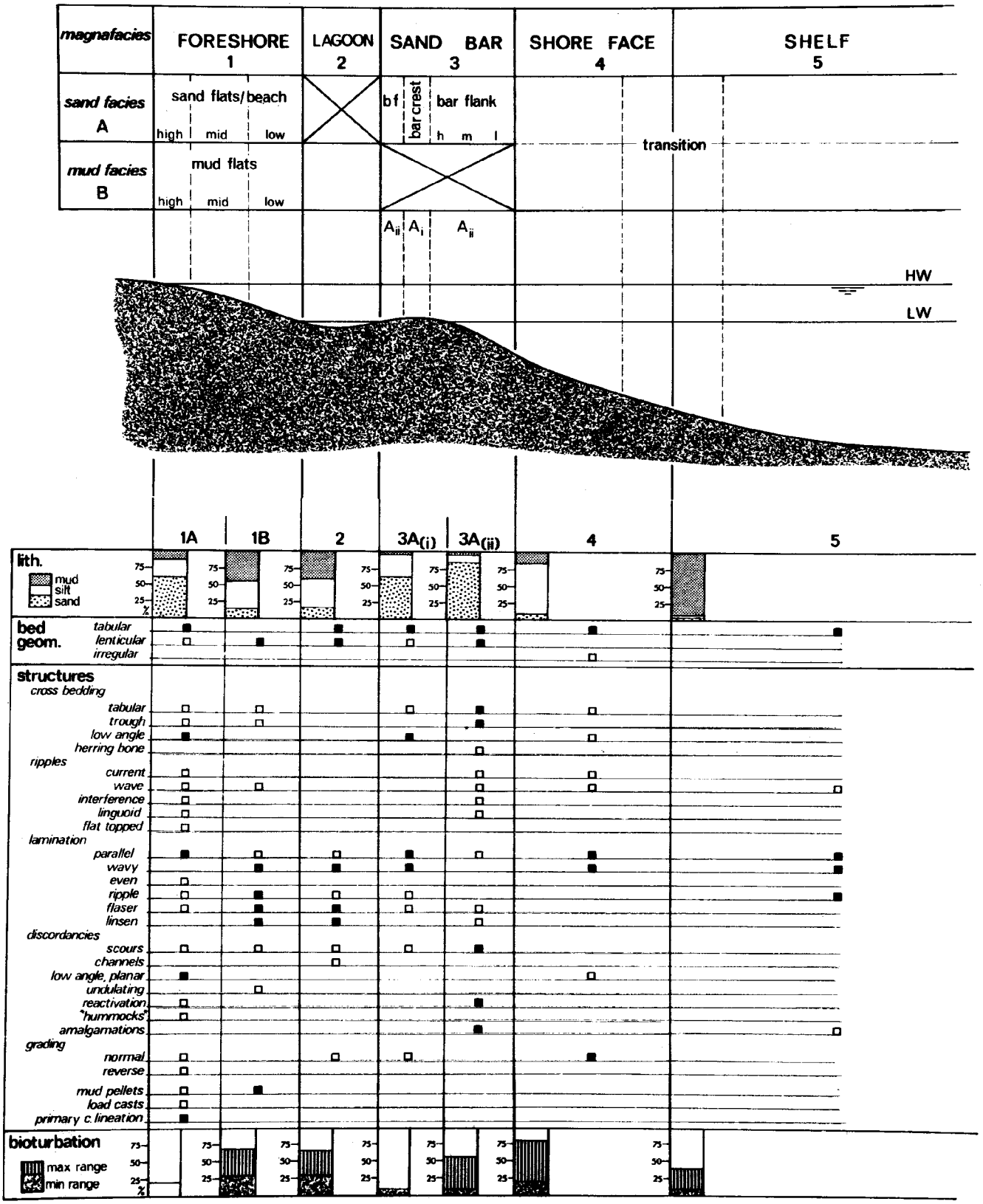

Fig. 2.—Lithofacies model for the Cabos Series between Cadavedo and Luarca. Distributions are shown in Fig. 1. Symbols indicate the levels of occurrence of diagnostic sedimentary structures: open squares = present; black squares = abundant.

the Cabos Series appears to represent a regressive phase of the basin development. The final 150 m of the Series indicates a probable return to transgressive conditions which continues throughout the deposition of the graptolitebearing Luarca Shales (cf. MARCOS, 1973) and culminated in the turbide input during the Agüeira Formation (Llandeilo-Caradoc age).

The transition at the base of the section between the Cabos Series and the underlying limestones and dolomites of the Vegadeo Formation is difficult to interpret due to the shattered and faulted state of the exposure. Equivalent formations exposed in the Cantabrian Zone indicate deposition in a tidal and shallow marine environment (ZAMARREÑO 1972) and similar conditions probably existed in the Asturias-leonese region. Thus the boundary between the Vegadeo Formation and the clastic Cabos Series presumable reflects an increase in the input of clastic detritus and not a fundamental change in the bathymetric environment.

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M. L. Fernández Secades (*).—PETROLOGIA Y GEOQUIMICA DE LAS MANIFESTACIONES EFUSIVAS DE LA REGION DE CABO DE PEÑAS (N. DE ASTURIAS)

Las rocas volcánicas que denominamos de Cabo de Peñas, aparecen en dos afloramientos, uno bajo el Faro de Peñas y otro en los acantilados de Viodo, distante del anterior unos 3 Km (Fig. 1).

La primera mención de las rocas volcánicas de Peñas se debe a SCHULTZ (1858), que las cita como pórfidos verdes o dioríticos. BARROIS (1882), les atribuye edad silúrica y las describe como rocas verdes, a las que llama mimófiros. LLOPIS-LLADO (1961) las considera cámbricas, mencionándolas como diabasas interestratificadas con areniscas. Posteriormente GARCÍA DE FIGUEROLA (1961), hizo una descripción de las mismas y RADIG (1962) las situó en el tránsito ordovícico-silúrico. Por último JULIVERT, TRUYOLS & GARCÍA-ALCALDE (1971), las incluyen en el ordovícico superior.

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