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POTENTIAL PALEOGENE / NEOGENE BOUNDARY STRATOTYPE SECTIONS IN SPAIN

by

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The aim of this communication is to present to the "Working group on the Paleogene / Neogene Boundary: I.U.G.S.- Commission on Stratigraphy - the best known sections of the Oligocene / Miocene boundary in Spain. Several sections have been studied in different Spanish regions in order to choose the most suitable which could be a Potential Stratotype of the Paleogene / Neogene boundary. The regions where the sections have been searched cover a great part of the Iberian Peninsula, mainly Aragon and Andalusia.

In Aragón the search in the Pyrenees, Ebro Basin and Iberian Cordillera has been unsuccessful, since due to its paleogeographic conditions during Oligocene and lower Miocene, the sedimentation was mainly of continental type with frequent evaporitic intercalations, these are the reasons why there are not suitable continuous marine sections. For the same reasons the whole zone of the Iberian Plateau has been excluded; the deposits of this time interval are even more sporadic -- and continental.

The part of Andalusia corresponding to the Betic Cordilleras has been studied in greater detail. These Betic Cordilleras form the great structural unit of the southern part of the Iberian Peninsula -- and form part of the alpine type Cordilleras. This mentioned Cordillera is divided into several zones oriented SW-NE in elongated bands.

GEOLOGIC SITUATION

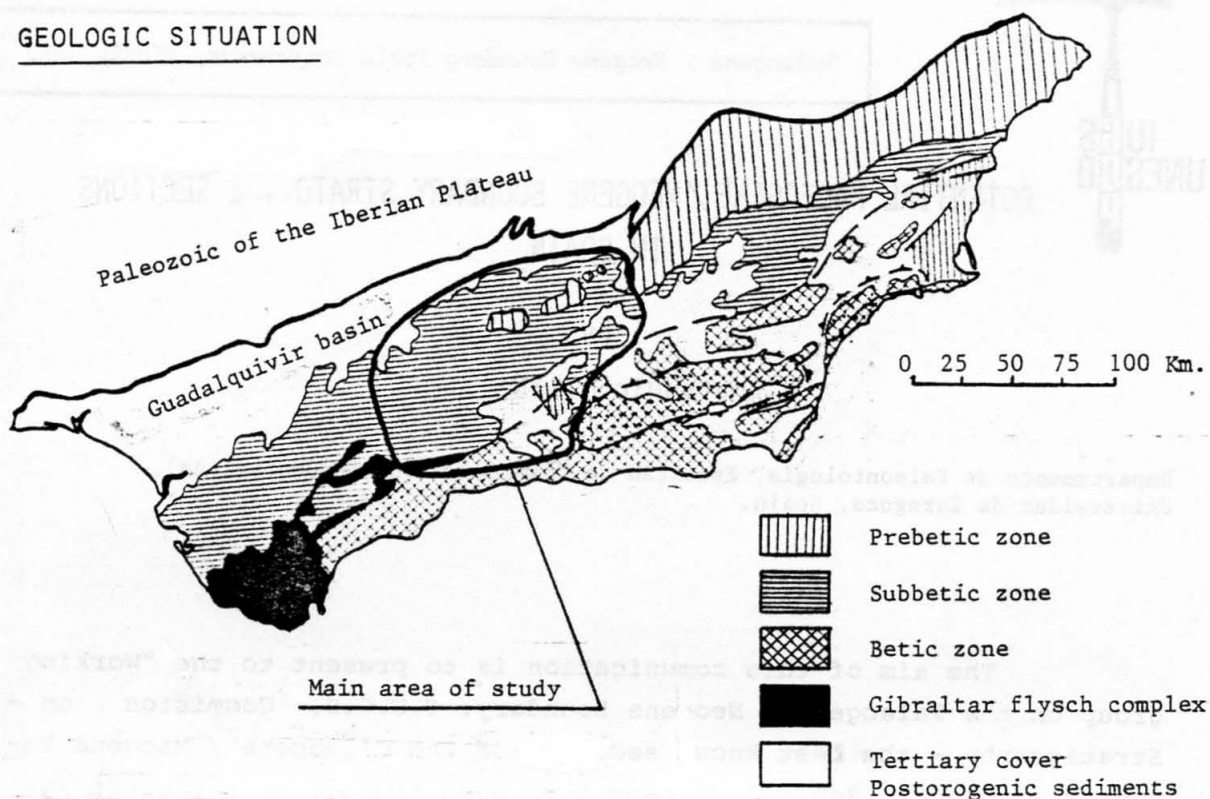


Fig. 1.- Structural scheme of the Betic Cordilleras
J. M. FONTBOTE (in JULIVERT et al., 1972)

In the eastern part of the Betic Cordilleras several sections have been quoted but at the moment their possibilities are still unknown. CREMADES (1979) studied the Eocene and Oligocene of the extreme oriental sector, quoting several sections which can probably continue during the Miocene but I have not carried out the inventory yet. SOEDIONO (1969), in Velez Rubio region studied the "Ciudad Granada" formation assigning an age from upper Chattian to lower Aquitanian. Recently, this section has been restudied by JUTSON (1980) as far as benthonic foraminifera are concerned. My intention in the near future is to sample this formation in order to evaluate the real possibilities it presents.

The area which presents the best possibilities is the central sector of the Betic Cordilleras; the bio and cronostratigraphic aspects of this area, have been studied by means of planktonic foraminifera, in my Doctoral thesis, MOLINA (1979). Apart from them, it has been possible to confirm the great abundance of benthonic foraminifera (specially macroforaminifera) and nannoplankton, as well as some other less frequent groups: algae, bryozoa, ostracoda and radiolaria.

In the zone of Rute (province of Cordoba) PEYRE (1974) found several sections, some of which we have recently sampled, and they are the following:

SECTION ALONG THE NEW ROAD FROM RUTE TO IZNAJAR

The lithology presents a marl and calcarenite alternance with an approximate thickness of 60 m. The Oligocene, with *G. sellii* and *G. angulisuturalis* zones, is well represented, but the section is interrupted in the lower part of *G. primordius* zone, which is a great disadvantage for our objectives.

SECTION OF THE PANTANO DE LA CAMORRA ROAD

It is situated 8 km. from the former; lithologically it presents some marls whose thickness is difficult to evaluate, but which roughly could be around 40 m. It belongs to the base of lower Miocene, to the *G. primordius* zone exactly and therefore it represents the continuation of the preceding section.

These two sections apparently are not the most suitable ones to establish the Oligocene / Miocene boundary, but nevertheless they show the great possibilities of this zone and the task now is to find a continuous section near them.

The zone of Moreda (province of Granada) is very interesting for the study of Oligocene and lower Miocene, due to the good outcrops it presents. I have studied in detail the following sections:

FUENTE CALDERA SECTION (PEDRO MARTINEZ)

It presents a thick series of 270 m., lithologically it is formed by an alternance of marls and calcarenites with an excellent exposure, which allows a very good sampling; although several olistostron levels have been recognized they are nevertheless perfectly localized. It presents optimum conditions to study the Eocene / Oligocene boundary. The Oligocene (*G. gortanii*, *G. tapuriensis*, *G. sellii*, *G. angulisuturalis* zones) is well represented but this section is not suitable for the study of the Oligocene / Miocene boundary. The top of the series presents a part with a very poor content of planktonic foraminifera altho-

ugh there are some benthonic ones, bryozoa, abundant *Microcodium* prisms and macroforaminifera which do not allow to state precisely the age - and consequently it is attributed with certain reservations to lower -- Miocene (Aquitanian).

ZARABANDA SECTION (GUADAHORTUNA)

Lithologically it presents an alternance of marls with calcarenites and calcirudites, with a slight predominance of marls. The section shows a whole thickness of over 137 m. The lower part of the section is interesting for the study of the upper Oligocene, *G. angulisuturalis* zone, which is represented by its two subzones of *G. (T.) o. opima* and *G. o. fariasi*. The datum plane of *G. primordius* which I have considered for the moment as the Oligocene / Miocene boundary, remains hidden by the road. Besides, in this place there is also a fault, all of which prevents the sampling of the mentioned boundary. *G. primordius* zone, though incomplete, has been identified in the upper part. It is represented by the upper part of *G. primordius* subzone and *G. (T.) semivera* subzone.

CAÑADA DE JAEN SECTION (EL GOBERNADOR)

The lithology is formed by an alternance of hard calcarenite strata with some other soft marly ones, with its whole thickness being over 130 m. The upper Oligocene, *G. angulisuturalis* zone with its two subzones of *G. (T.) o. opima* and *G. o. fariasi*, is well represented in the lower part. The Aquitanian, *G. primordius* zone with its three subzones of *G. primordius*, *G. (T.) semivera* and *G. trilobus s.l.*, outcrops in the upper part. The interest of this section lies in the fact that the boundary from *G. (T.) semivera* subzone to *G. trilobus s.l.* is well represented; however, the limit between *G. angulisuturalis* and *G. primordius* zones, which is really the important one, is covered by debris. Unfortunately, as in Zarabanda section, it prevents the sampling and it is the reason why these two sections are unsuitable as potential stratotypes, although they could have been excellent but for the fact of the mentioned problems of continuity.

BUDEO SECTION (RIVER FARDES BASIN)

The lithology is entirely formed by marls mainly of grey colour, except in the upper part where two yellowish levels are interca-

lated. It is difficult to evaluate the whole thickness of the sampled series, since the lithology does not allow us to see the dip properly, but it can be estimated of around 35 m. Most of the series belong to the base of *G. primordius* zone, more exactly to the homonym subzone. The fine development of the series, as well as a detailed sampling allows, when we study the samples, to notice the slow occurrence of *Globigerinoides primordius*, which appears for the first time on the base of the series, with a low frequency, but which becomes very abundant to the top of the series. The main difficulty of this section lies on its small vertical distribution, since it only covers the top of the *G. angulisuturalis* zone and the base of *G. primordius* zone which makes it unsuitable for our present purposes.

AZAGAHOR SECTION (ALAMEDILLA)

The lithology presents an alternance of marls with big calcarenite and calcirudite strata, with clear predominance of marls. The whole thickness is about 75 m. A recurrence of the series has been deduced, probably due to an inverse fault. In the Oligocene, the upper part of *G. sellii* zone and the whole *G. angulisuturalis* zone has been recognized. The first *Globigerinoides primordius* appear towards the upper part of the section, with a progressive impoverishment of the planktonic fauna; on the contrary there is a great abundance of *Microcodium* prisms and benthonic foraminifera, specially macroforaminifera. This section, which at first sight could be suitable as potential stratotype, has the inconvenience of the early interruption in its upper part and the lower Miocene appears badly represented.

NAVAZUELO SECTION (Fig. 2)

It is the best section of the Oligocene / Miocene boundary of all found in Spain until the present time. It is exceptional due to its good conditions of observation, thick marine and continuous series, very rich in fauna and because it ranges nearly the whole interval N.1 (=P.20) / N.4 of BLOW (1969) zonation. I found it during my Licenciatura thesis, MOLINA (1975) and it was the basic section. MARTINEZ-GALLEGO (1977) as well included it in his Doctoral thesis and established a zonation for the upper Eocene and Oligocene. Later, GONZALEZ-DONOSO and MOLINA (1977-78) proposed this Navazuelo section as a

hipostratotype (maybe holostratotype, if better sections are not found) for the Oligocene / Miocene boundary.

The series presents a general dip of 20° southwards; the whole thickness of the exposed part approaching 250 m. From bottom to top it presents little variation in lithology, being a rhythmic alternance of calcarenites and marls, with a predominance of some or the other in the different sectors of the series. The following geological terms of the series can be established from bottom to top:

- a) 20 m. of mainly marly materials of dark grey colour, belonging - to *G. sellii* zone.
- b) 60 m. of rhythmic alternance of calcirudites and calcarenites with marls. Most of the materials correspond to *G. angulisuturalis* - zone; to the top of this term, the series becomes more calcareous and the limit of *G. primordius* zone is localized.
- c) 70 m. of mainly calcarenitic materials but with marly levels intercalated, that allows them to be attributed to *G. primordius* zone as well.
- d) 45 m. of alternance of calcarenites and calcirudites with some - intervals of well developed marls, belonging also to *G. primordius* zone.
- e) At the top of the series, in Cerro Granado, 50 m. of flysch facies materials very rhythmic, with a big development of parallel and convolute lamination. The sandy fraction is abundant - and in the marly intervals, light in colour, an impoverishment - of the planktonic fauna can be appreciated.

All these sections are the most suitable at present. There are many possibilities of finding some better ones, since the area is very wide and the marine sedimentation very frequent, for this time interval. Among them all, for the moment the most suitable one is the Navazuelo section (Betic Cordilleras, province of Granada) that is why I propose it to this working group as a potential stratotype of Paleogene / Neogene boundary in Spain.

In relation to the content in planktonic foraminifera in Navazuelo section, which can apply as well to the rest of the sections - shown in this paper, the following has been confirmed:

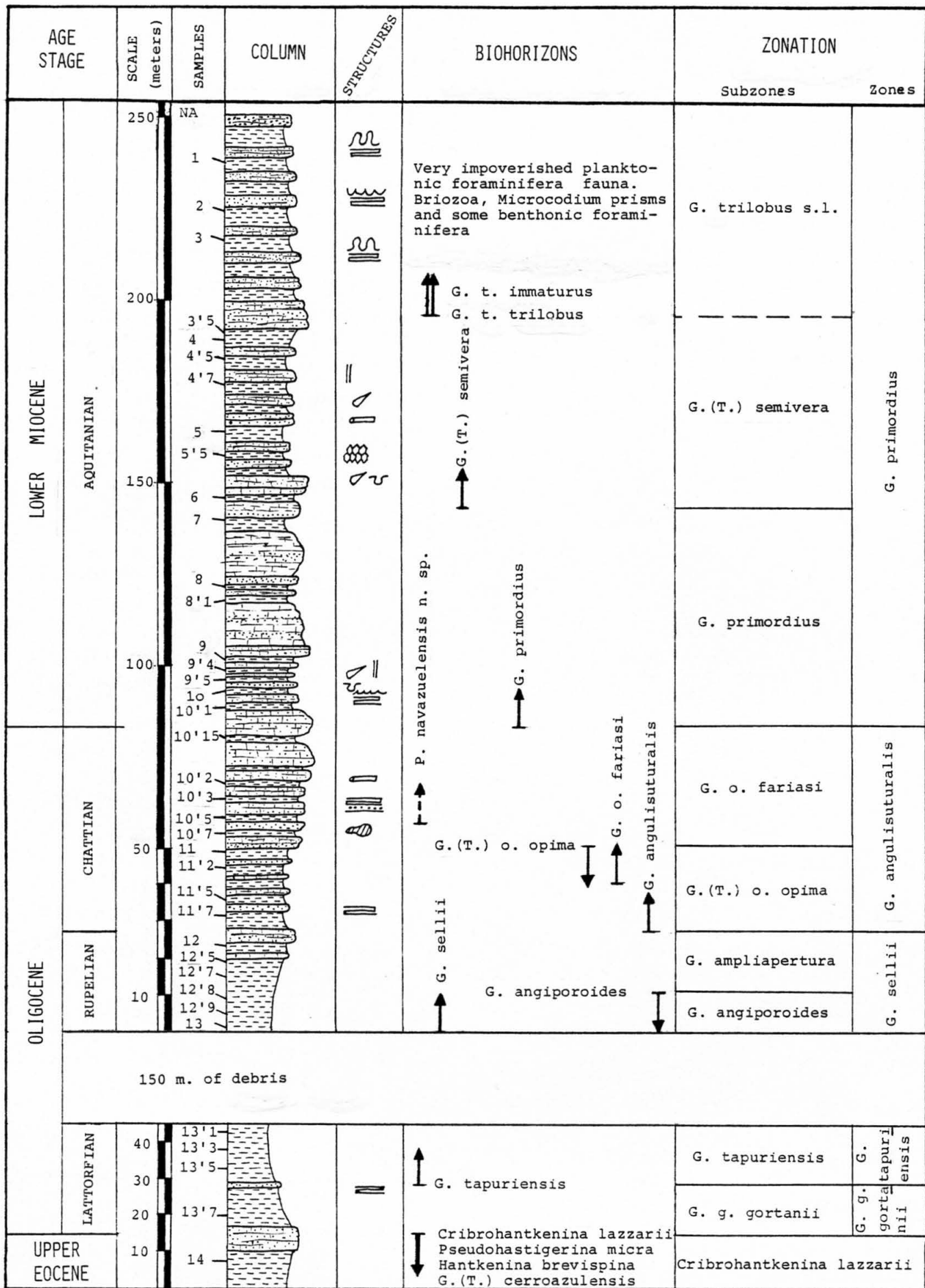


FIG. 2.- NAVAZUELO SECTION

- 1) In the abundant fauna of planktonic foraminifera of our region - there are (although rare) certain tropical forms, which would make easier the correlation of the zonation of more southern region with the northern ones.
- 2) *Globorotalia (Turborotalia) kugleri* is extraordinarily rare and appears very sporadically, as it occurs in wide areas of the Mediterranean, and consequently it has not been used as a zonal marker.
- 3) *Globigerinoides primordius* is very abundant and the gradual appearance can be followed from forms with a very small secondary -- opening to very developed ones. In our region this occurrence - constitutes a good datum plane, which is a very important reason to keep it for the moment, as a marker of the Oligocene / Miocene limit until another one is found.
- 4) Some species make their first appearance close in time to *Globigerinoides primordius*. Among them those which are nearer are -- *Globigerinita incrusta*, *Globorotalia (T.) pseudocontinua* and *Protentella navazuelensis*, this latter constitutes a link in the phylogenetic line of *G. (T.) obesa* to *P. proluxa*.
- 5) Some other species are well represented in nearly all the sections, among the more important we can find: *Globigerina sellii*, - *Globigerina angiporoides*, *Globigerina ampliapertura*, *Globigerina angulisuturalis*, group of *Globigerina praebulloides*, group of *Catapsidrax dissimilis*, group of *Globorotalia (T.) opima*, *Globorotalia (T.) semivera*, etc.

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