Geologie en Mijnbouw **75:** 87–90, 1996.

Short communication

Discussion: Triassic-Miocene paleogeography and basin evolution of the Subbetic Zone between Ronda and Málaga, Spain, by Freek van der Meer, *Geologie en Mijnbouw 74: 43–63, 1995*

A. Martín-Algarra[1,2], A.C. López-Garrido[2], C. Sanz de Galdeano[2] & M. Martín-Martín[1]
[1] *Departamento de Estratigrafía y Paleontología, Facultad de Ciencias, Universidad de Granada, 18071 Granada, Spain;* [2] *Instituto Andaluz de Ciencias de la Tierra, Facultad de Ciencias (C.S.I.C. – Universidad de Granada), 18071 Granada, Spain*

Received 24 October 1995; accepted in revised form 17 January 1996

In his paper, Van der Meer tries to reconstruct the Triassic-Miocene palaeogeography and basin evolution of the Subbetic Zone between Ronda and Málaga. However, the area between Ronda and Málaga does not correspond primarily to the Subbetic Zone, but principally to the Internal Zones of the Betic Cordillera and, to a much lesser extent, to the Campo de Gibraltar Complex. The latter is backthrusted on the Burdigalian transgressive sediments, that were unconformably deposited on the Internal Zones in the Alora-Casarabonela-Tolox region. The Campo de Gibraltar Complex and the Rondaide Complex (or external Dorsale of French authors) outcropping extensively in this area are ignored in Van der Meer's Figure 2. The Subbetic units are present only in the area immediately to the south and east of Ronda. However, they constitute only a small part of the most internal areas of the Penibetic (westernmost Internal Subbetic): Sierras Hidalga, Blanquilla and Merinos. Thus, the Median and External Subbetic and the units forming a transition to the Prebetic are not present.

When Van der Meer states that 'relatively few recent studies have been undertaken in the western part of the orogen', he ignores the great number of papers published about the geology of this area by different authors from many countries, many of which are Ph.D. theses with an abundance of stratigraphical, palaeontologic, sedimentological, tectonical, structural, palaeomagnetic, petrological and geochemical data (Cruz-Sanjulián 1974; Pendón 1978; González-Donoso et al. 1983; Olivier 1984; Martín-Algarra 1987; Thurow 1987; Platzmann 1992; and numerous geological maps). These studies concern the Internal or External Zones, or the Campo de Gibraltar Complex.

Van der Meer also states that 'stratigraphic mapping and facies analysis allow to reconstruct palaeoenvironments' (*sic*, p. 43) and that his observations are focused 'on the exposed sequences north and east of Ronda and on Neogene deposits north of El Burgo' (p. 45). However, he did not make these studies himself and he does not mention his sources, with the exception of four unpublished reports made by ITC students in which 29 sections constitute the main data base. In fact, a complete confusion between data obtained from different outcrops and tectonic units is evident from the examination of both the text and the figures, none of which matches the geological reality of the area. It is curious that the author does not mention any of the classical sites with clearly visible outcrops, which have been known for a long time and where the most important observations about the geology of the Málaga-Ronda area have been made (El Chorro, Torcal de Antequera, northern foothills of Sierra Hidalga, Sierra Blanquilla, Río de la Venta, east of Teba, and many other sites). On the contrary, most of the sites in Figure 2 represent poor outcrops where only fragmentary and incomplete stratigraphical or tectonical observations can be made.

Moreover, the author completely ignores the tectonic structure of the area, and assigns outcrops to the Subbetic Zone that actually belong to other tectonic units. This is the case with points 4, 5, 7, 8, 10, 12, 14, 15, 18, 19, 23, 24, 26, 27, 28 and 29. All of them are located within the Campo de Gibraltar Complex, mainly in areas with a great development of clays. In none of these sites, nor in points 1, 2, 8, 9, 16, 17, 21, 22, 25 and 26, do we find a continuous section with a substantial portion of the rock record in good exposures, enabling us to establish the stratigraphy.

We also wish to mention several specific points:

a) Triassic

Figure 4 does not correspond to any Triassic succession outcropping near Ronda. The excellent work by Dürr (1967: pp. 9–11, Figure 4) and the more recent study by Martín-Algarra (1987: pp. 60–68, Figures 14–16, 18 and 21) provide a detailed insight into the Triassic stratigraphy of the area. Some details are:

- No 'red-coloured conglomerates and sandstones. . .' (p. 45) exist in the Subbetic (Penibetic) succession to the east of Ronda. These are present only in the Convento de las Nieves and near Alozaina, in outcrops which actually belong to the Malaguide Complex and which are extremely tectonized. No dating of these rocks has ever been published.
- The 'dolomites containing *Myophoria*. . .' (p. 47) are rather vermiculated limestones belonging to the Penibetic succession. They are not overlain by the dolomitic succession with Alpine facies containing abundant dasycladacean algae described by Dürr (1967), and studied in detail with regard to its sedimentological features by Martín-Algarra (1987). The dolomites (Carnian-Norian) belong to the Internal Zones (Rondaides or Nieves Unit) and overthrust both the Campo de Gibraltar Complex and the Penibetic succession. They are more than 1100 m thick, not 110 m.
- The Upper Triassic, stratigraphically overlying the Middle Triassic of the Penibetic, and outcropping at many places in the northern foothills of Sierra Hidalga, shows no reef or backreef facies, but rather a peritidal dolomitic facies associated with variegated clays, sandstones and gypsum in a typical Germanic Keuper facies association.
- The Triassic to the north of Campillos belongs to other Subbetic units which are completely different from those cropping out near Ronda, and its thickness is much greater than that of the Keuper of the Penibetic. The brecciation of the rocks in these outcrops is so intense that the stratigraphical relationships cannot be established. In any case, no coarse alluvial deposits have ever been described in the Triassic deposits of this area.

b) Jurassic

Van der Meer mixes observations made in the Penibetic and other Subbetic units with a completely different stratigraphical succession. The columns reproduced in his Figure 5 do not correspond to any observation that could be made either at his point 2, or at any other site in this area. Marls, marly limestones and sandstones do not exist in the Jurassic succession of the Penibetic, particularly not in the Dogger which corresponds to the most calcareous part of the Jurassic succession. The corals cited by Dürr (1967) come from the area of the Jarastepar, southwest of Ronda, but their dating as Malm can now be ruled out in the light of more recent data, in particular the presence of nodular limestones rich in ammonites of the Middle Oxfordian throughout the Penibetic (Cruz-Sanjulián 1974; Sequeiros 1974), just above the coral-bearing limestone formation. The latter should correspond to the top of the Dogger (Calizas de Coral de Villaluenga Member within the Endrinal Fm. of Martín-Algarra 1987).

The unit recognized by Van der Meer, referring to the work of Delgado & Sanz de Galdeano (1981), does not correspond to the Penibetic, but to the Median Subbetic. Van der Meer has mixed the various Subbetic domains indifferently, without taking into account their diverse palaeogeographical origins.

c) Cretaceous

Van der Meer made the same indiscriminate mixture of the Cretaceous, which is completely pelagic in the area near Ronda. No *Praealveolina* has ever been found in the Cretaceous of the Penibetic, which is made up entirely of marly to calcareous rhythmites rich in planktonic foraminifera (with some cherty beds in the Cenomanian-Turonian). Resedimented shallow-water benthic foraminifera have been found in the provinces of Cádiz and Málaga (not in the Penibetic, but in the Late Senonian 'Flysch à Microbrèches' of the French authors, e.g. Didon (1969), Peyre (1974) and Bourgois (1978)). These formations are typical of some Campo de Gibraltar units that tectonically overlie the Penibetic (particularly the Algeciras, Boyar, Ubrique and Argüelles units; see also Martín-Algarra 1987). No Cretaceous occurs '5 km north of Antequera' (p. 49); this area is the centre of the Neogene-Quaternary Antequera basin filled with recent alluvial sediments of the Guadalhorce River (see the geological maps of the area, in particular the 1/50000 IGME sheet 1023 (Antequera: Martín-Serrano García 1986).

d) Tertiary

Van der Meer's confusion between stratigraphical, palaeontological and sedimentological information from different outcrops is especially dramatic with regard to the Tertiary, where information derived from the different Campo de Gibraltar units has been mixed with observations made in the Penibetic and the Malaguides. The author mentions the presence of Tertiary Subbetic outcrops in Ardales, El Burgo and Teba, which actually do not exist at all in shallow-water facies, and makes inadmissible palaeoecological inferences for the Subbetic Zone from benthic foraminifera and other microfossils that occur throughout the calcareous turbidites belonging to the Campo de Gibraltar Complex.

With regard to the Late Oligocene–Early Miocene, the author presents three palaeogeographical reconstructions. Figure 9 fails to take into account the existing tectonic model explaining the geodynamic evolution of the Betic-Rif region during the Oligocene and the Neogene. His figures are incompatible with any of the models of Durand-Delga (1980), Doblas & Oyarzun (1989), Platt & Vissers (1989), Sanz de Galdeano (1990), and others. All of these models accommodate, in different ways, the displacement of the Internal Zone relative to the External Zone, in such a way that during the Aquitanian or the Burdigalian these zones were not in the same position as at present.

Figure 10 reveals the ignorance of the important Burdigalian outcrops in the Málaga Basin (Boulin et al. 1973; Bourgois 1978; Martín-Algarra 1987; Sanz de Galdeano et al. 1993).

With regard to the Tortonian, the author states that the Early Tortonian of Ronda is made up of '. . .marls (200 to 300 m thick) with an upward increase of sandstone intervals containing minor halite intercalations. . .' (!!! p. 51), overlooking the presence of the impressive Tajo of Ronda, composed of more than 150 m of calcareous conglomerates overlain by cross-bedded bioclastic calcarenites. Moreover, during the Tortonian there was a connection between the Atlantic and the Mediterranean (López-Garrido & Sanz de Galdeano 1991; Sanz de Galdeano & López-Garrido 1991).

As a whole, Figure 11 is not correct. The Tortonian is wholly independent of the original Subbetic Basin, and has a completely different facies. Furthermore, in the Málaga Basin the Tortonian deposits are composed of marine bioclastic sand waves (calcarenites) and conglomerates (e.g. directly to the west of Alora) coexisting with emerged areas; these occur, for example, to the west of Torremolinos, in the Sierra de Mijas (López-Garrido & Sanz de Galdeano 1994; Sanz de Galdeano & López-Garrido 1991). Finally, the supposed shoreline of the Tortonian in Figure 11, in the Málaga-Casarabonela sector, coincides exactly with the Pliocene shoreline and also with the marly facies. We believe, therefore, that there is major confusion with the Pliocene palaeogeography (compare Figure 11, p. 55 of Van der Meer, with Figure 4D, p. 177 of Sanz de Galdeano & López-Garrido 1991).

Conclusion

It is difficult to comment on Van der Meer's palaeogeographical reconstructions and backstripping analysis, because they have been made on the basis of a completely erroneous 'synthetic' column in which stratigraphies from many different tectonic units are jumbled. It should also be mentioned that several important papers about the geology of the area are not taken into account.

In short, we believe that the errors, omissions and confusion in the study of Van der Meer should be corrected to avoid misconceptions about the geology and the palaeogeography of the Subbetic Zone and of the area between Ronda and Málaga.

Acknowledgements

This study forms part of the Research Project PB93-1150, PB94-0050 (DGICYT) and the Research Groups 4085 and 4089 of the Junta de Andalucía.

References

Boulin, J., J. Bourgois, P. Chauve, M. Durand-Delga, J. Magne, V. Mathis, Y. Peyre, M. Rivière & J.A. Vera 1973 Age miocène inférieur de la formation de la Viñuela, discordante sur les nappes internes bétiques (Province de Málaga, Espagne) – Comptes Rend. Acad. Sci. Paris 276: 1245–1248

Bourgois, J. 1978 La transversale de Ronda. Cordillères Bétiques, Espagne. Données géologiques pour un modèle d'évolution de l'Arc de Gibraltar – Ann. Sci. Univ. Besançon 30, 445 pp

Cruz-Sanjulián, J.J. 1974 Estudios geológicos del sector Cañete la Real-Teba-Osuna. Thesis Univ. Granada 71, 431 pp

Delgado, F. & C. Sanz de Galdeano 1981 Estudio geológico de la Sierra de Gibalto y sectores próximos (provincias de Granada y Málaga) – Estudios Geol. 37: 69–75

Didon, J. 1969 Etude géologique du Campo de Gibraltar (Espagne méridionale), Thesis Univ. París, 539 pp

Doblas, M. & R. Oyarzun 1989 Neogene extensional collapse in the western Mediterranean (Betic-Rif Alpine orogenic belt): Implications for the genesis of the Gibraltar Arc and magmatic activity – Geology 17: 430–433

Durand-Delga, M. 1980 La Méditerranée occidentale: étapes de sa genèse et problèmes géodynamiques liées à celle-ci – Mém. Soc. Géol. France 10: 203–224

Dürr, S.H. 1967 Geologie der Serrania de Ronda und ihrer sudwestlichen Ausläufer (Andalusien) – Geol. Romana 6: 1–73

González-Donoso, J.M., D. Linares, A. Martín-Algarra, M. Rebollo, F. Serrano & J.A. Vera 1983 Discontinuidades estratigráficas durante el Cretácico en el Penibético – Estudios Geol. 29: 71–116

López-Garrido, A.C. & C. Sanz de Galdeano 1991 La comunicación en el Tortoniense entre el Atlántico y el Mediterráneo por la cuenca del Guadalhorce (Málaga). 1er. Congr. Esp. Terciario. Vic. Barcelona: 190–193

López-Garrido, A.C. & C. Sanz de Galdeano 1994 Neogene sedimentary infilling and tectonic/eustatic control of the Málaga basin. RCMNS Int. Coll. 'Neogene Basin Evolution and Tectonics of the Mediterranean Area', Abstracts: 48–50

Martín-Algarra, A. 1987 Evolución Geológica Alpina del contacto entre las Zonas Internas y las Zonas Externas de la Cordillera Bética. (Sector Central 4 Occidental). Thesis Univ. Granada, 1171 pp

Martín-Serrano García, A. 1986 Mapa y memoria explicativa de la Hoja n° 1023 (Antequera). Mapa geológico de España 1 : 50.000. plan MAGNA, Inst. Geol. Min. Esp., 48 pp

Olivier, P. 1984 Evolution de la limite entre Zones Internes et Zones Externes dans l'Arc de Gibraltar (Maroc-Espagne). Thesis Univ. Paul Sabatier, Toulouse, 229 pp

Pendón, J.G. 1978 Sedimentación turbidítica en las unidades del Campo de Gibraltar. Thesis Univ. Granada, 260 pp

Peyre, Y. 1974 Etude Géologique d'Antequera et de sa région (Cordillères Bétiques, Espagne). Thesis Univ. Paris, 528 pp

Platt, J.P. & R.L.M. Vissers 1989 Extensional collapse of thickened continental lithosphere: A working hypothesis for the Alboran Sea and Gibraltar arc – Geology 17: 540–543

Platzmann, E.S. 1992 Paleomagnetic rotations and the kinematics of the Gibraltar arc – Geology 20: 311–314

Sanz de Galdeano, C. 1990 Geologic evolution of the Betic Cordilleras in the Western Mediterranean, Miocene to the present – Tectonophysics 172: 107–119

Sanz de Galdeano, C. & A.C. López-Garrido 1991 Tectonic evolution of the Málaga Basin (Betic Cordillera). Regional implications – Geodinamica Acta 5(3): 173–186

Sanz de Galdeano, C., F. Serrano, A.C. López-Garrido & J.A. Martín-Pérez 1993 Palaeogeography of the late Aquitanian–early Burdigalian Basin in the western Betic Internal Zone – Geobios 26(1): 43–55

Sequeiros, L. 1974 Paleobiogeografía del Calloviense y Oxfordiense en el sector central de la Zona Subbética. Thesis Univ. Granada 65, 636 pp

Thurow, J. 1987 Die Kretazische Turbiditeserien im Gibraltarbogen: Bindeglied zwischen atlantischer und tethyaler Entwicklung. Thesis Univ. Tübingen, 496 pp

Van der Meer, F. 1995 Triassic-Miocene paleogeography and basin evolution of the Subbetic Zone between Ronda and Málaga, Spain – Geol. Mijnbouw 74: 43–63