

## REPLY TO DISCUSSION ON «U-PB GEOCHRONOLOGY FOR THE BARREIROS TECTONISED GRANITOIDS AND ARRONCHES MIGMATITIC GNEISSES: TOMAR CORDOBA SHEAR ZONE, EAST CENTRAL PORTUGAL»

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Reply to discussion on «U-Pb geochronology for the Barreiros tectonised granitoids and Arronches Migmatitic Gneisses: Tomar Cordoba Shear Zone, East Central Portugal». *Rev. Soc. Geol. España*, 15 (3-4), 253-255

We thank Pereira and Silva for their comments levelled at a past publication (de Oliveira *et al.*, 2002), which provides a base for the ensuing comments in reply.

Our approach to de Oliveira *et al.*, (2002) is based on the presentation of new geochronological data for two of the lithologies outcropping within the Tomar Cordoba Shear Zone (TCSZ) and to highlight many of the questions, in terms of age of rocks, that remain unanswered in the Portuguese sector of the TCSZ and it was never the intention to write a "structural geology-based manuscript". The comments received pertain mostly to the tectonic evolution of this highly complex zone and it was not our intention to misquote or mislead anyone and we stand corrected on some of the points raised by Pereira and Silva (this volume) but we would like to reply to a few specific comments.

### Specific comments

*Location of the OMZ/CIZ boundary* – Admittedly Pereira and Silva (2000) do not place the boundary between these two major tectonostratigraphic zones in Spain and the reference is misplaced in the sentence.

*Structure of the TCSZ with respect the errors reported in the general geological map* – The repeated errors referenced by Pereira and Silva (this volume) denotes the unnecessary detail with which they have commented on the paper. – a) The general geological map used, edited by the *ex-Serviços Geológicos de Portugal* (now the *Instituto Geológico e Mineiro*) and coordinated by Oliveira *et al.*, (1992), remains one of the foremost works of reference for Portuguese geology. Pereira and Silva (this volume) have misinterpreted its use and

objective since the map was used to locate the two samples collected and to give a brief but very summarised geological background to the reader. Furthermore, it is clear and implied that the map was compiled using areas mapped in more detail at the larger 1:50.000 scale (e.g. Gonçalves, 1971; Assunção and Gonçalves, 1970; Gonçalves and Assunção, 1970; Coelho and Gonçalves, 1971; Gonçalves and Fernandes, 1973; Gonçalves and Carvalhosa, 1994; Gonçalves and Peleja, 1971; Gonçalves *et al.*, 1972a; 1972b; 1978; amongst others) and is not trying to detract anything from their previous important work; b) The failure to recognise the existence of black metacherts stems from the fact that presently, it is better to class the arenitic component of the Série Negra in terms of general terms such as meta-arenite and metapelite. The reasons for this are two-fold: i) the term chert implies a chemical sediment deposited in a specific environment and, ii) we are in possession of, as yet unpublished (de Oliveira *et al.*, *in prep.*), data that clearly shows these units to have a probable clastic precursor and should therefore be termed quartzites rather than cherts; c) With respect the use of the terms "pelites and greywackes" to describe the Urra Formation rocks, we would like to say that these terms are used *senso lato* and not *senso stricto*. The term greywacke stems from 1789 to describe rocks from the Harz Mountains in Germany (Blatt *et al.*, 1980). The definition of the term has seen many, at time controversial, evolutions such that at times it has been suggested that it be scrapped altogether (see Dott, 1964 on the evolution of the terminology). However, today the term greywacke is applied to rocks of sand-size sediment with an important component of phyllosilicate minerals (Blatt *et al.*, 1980) and basically refers to immature sandstones

(Allaby and Allaby, 1990). On the other hand, the term pelite simply denotes a metamorphosed sedimentary rock with a clay component (Allaby and Allaby, 1990). Hence, these two terms are perfectly useful, in our opinion, to describe the Urro Formation rocks (*s.l.*).

*Age of the migmatitic gneisses-* a) The geochronological dating method used by de Oliveira *et al.* (2002) is clearly stated as “single-zircon grain” and not “multi-zircon grain” dating as stated in Pereira and Silva (this volume). In other words, each ellipse on the concordia plots (Figs. 2 and 3 in de Oliveira *et al.*, 2002) represents one grain of zircon and not several grains of zircon; b) The ID-TIMS technique is still considered, in ours and in many others opinion, the most accurate technique to date samples. It is however acknowledged that in the case of complex zircon grains (i.e. with inherited core and/or overgrowth) the SHRIMP technique allows to discriminate the different ages, which is not possible with the ID-TIMS technique used in this study. The scattering of the data in Fig. 3 demonstrates that the zircons extracted from the migmatitic gneiss were affected by complex lead-loss and/or recrystallisation. It is acknowledged that it is not possible at this stage to exclude the possibility that the Proterozoic date found with some of the zircons analysed is inherited.

Pereira and Silva (this volume), regarding the age of the migmatitic gneisses, further state: “How can it be possible to consider a Palaeoproterozoic age for the tectonic...?”. In de Oliveira *et al.*, (2002) it is clearly written that we are stating *protolith* ages. The definition of protolith is clearly given as “the unmetamorphosed rock from which a given metamorphic rock was formed by metamorphism, i.e. *parent rock*” (Bates and Jackson, 1980). In the case of the geochronological data from the migmatitic gneisses (de Oliveira *et al.*, 2002), we clearly see a discordia age of around 2 Ga, i.e. a protolith age – the age of the parent rock. The data also clearly shows concordant ages of  $571 \pm 63$  Ma that are identical within error of the many age data (e.g.  $566 \pm 8$ ,  $509 \pm 8$ ; Ordoñez-Casado, 1998) quoted by Pereira and Silva (this volume) for the age of the high-grade metamorphism in this unit, de Oliveira *et al.*, (2002) also clearly state that the geochronological data obtained for this unit “do not define a simple, single group or trend, which may indicate the presence of more than one age population and probably the effects of more than one Pb-loss event”. However, we do acknowledge the possibility that the sample collected of the migmatitic gneisses in the Arronches area may have a sedimentary precursor, i.e. paragneiss, although this is not proved. In this case, the Palaeoproterozoic age may be inherited in which case the protolith age should coincide with  $571 \pm 63$  Ma or even  $431.2 \pm 6.4$  Ma (de Oliveira *et al.*, 2002). If, as Pereira and

Silva (this volume) state: “...the main criteria to define this tectonic unit is the character of the high-grade metamorphism and not the protolith ages...”, then this is clearly a case for interpretation of the geochronological data and we leave this up to discerning reader to filter the data to suit his or her model.

## References

- Allaby, A. y Allaby, M. (1990): *Concise Dictionary of Earth Sciences*. Oxford University Press, Oxford, New York, 410p.
- Assunção, C. T. de y Gonçalves, F., (1970): Contribuição para o conhecimento das rochas hiperalcalinas e alcalinas (gnaisses hastingsíticos) do Alto Alentejo (Portugal). *Separata do Boletim da Sociedade Geológica de Portugal*, 17, 187-228.
- Bates, R.L. y Jackson, J.A. (1980): *Glossary of Geology*, 2<sup>nd</sup> ed., American Geological Institute, 751p.
- Blatt, H., Middleton, G. y Murray, R. (1980): *Origin of Sedimentary Rocks*, 2<sup>nd</sup>. Ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 782p.
- Coelho, A.V.P. y Gonçalves, F. (1971): Novos elementos sobre gnaisses nefelínicos e rochas hiperalcalinas albiticas do Alto Alentejo. *Separata do Boletim da Sociedade Geológica de Portugal*, V.XVIII, 105-117.
- de Oliveira, D. P. S., Poujol, M. y Robb, L.J. (2002): U-Pb geochronology for the Barreiros tectonised granitoids and Arronches migmatitic gneisses: Tomar Cordoba Shear Zone, east central Portugal. *Revista Sociedad Geológica de España*, 15 (1-2), 105-112.
- de Oliveira, D. P. S., Reed, R. M., Milliken, K. L., Robb, L. J., Inverno, C. M. C. y d'Orey, F. L. C. (*in prep.*). Série Negra black quartzites – TCSZ, E. Portugal: *Mineralogy and cathodoluminescence studies*.
- Dott, R.H., Jr. (1964): Wacke, Greywacke and Matrix-what approach to immature sandstone classification? *Journal Sedimentary Petrology*, 34, 625-632.
- Gonçalves, F. (1971): Subsídios para o conhecimento geológico do nordeste Alentejano. *Memória N° 18 (Nova Série), Serviços Geológicos de Portugal*, 62p.
- Gonçalves, F. y Assunção, C.T. (1970): *Geological map of Portugal, Sheet 37-A (Elvas), Scale 1:50.000*. Serviços Geológicos de Portugal.
- Gonçalves, F. y Peleja, A. F. (1971): *Geological map of Portugal, Sheet 33-C (Campo Maior), Scale 1:50.000*. Serviços Geológicos de Portugal.
- Gonçalves, F. y Fernandes, A. P. (1973): *Notícia explicativa da folha 32-B (Portalegre)*. Serviços Geológicos de Portugal, 45p.
- Gonçalves, F. y Carvalhosa, A. (1994): O Proterozóico da Zona de Ossa Morena no Alentejo.

- Síntese e actualização de conhecimentos. *Memórias da Academia das Ciências de Lisboa*, Tomo 34, 3-35.
- Gonçalves, F., Assunção, C.T. y Coelho, A.V.P., (1972a): *Notícia explicativa da folha 33-C (Campo Maior)*. Serviços Geológicos de Portugal, 41p.
- Gonçalves, F., Peleja, A. F. y Jardim, J. J. (1972b): *Geological map of Portugal, Sheet 32-B (Portalegre), Scale 1:50.000*. Serviços Geológicos de Portugal.
- Gonçalves, F., Perdigão, J. C., Coelho, A. V. P. y Munhá, J. M. (1978): *Notícia explicativa da folha 33-A (Assumar)*. Serviços Geológicos de Portugal, 37p.
- Oliveira, J.M.T., Ramalho, M., Antunes, M.T. y Monteiro, J.H. (1992): *Geological Map of Portugal, Scale 1:500.000*. Serviços Geológicos de Portugal.
- Ordoñez-Casado, B., (1998): *Geochronological studies of the Pre-Mesozoic basement of the Iberian Massif: The Ossa Morena Zone and the allochthonous complexes within the Central Iberian Zone*. PhD thesis, Swiss Federal Institute of Technology Zürich, ETH N° 12.940, 233p.
- Pereira, M. F. y Silva, J.B. (2000): Sinistral transcurrent transpression at the Ossa Morena Zone/Central Iberian Zone boundary: The Portalegre-Esperança shear zone (Portugal). *Geogaceta*, 29: 131-134.
- Pereira, M.F. y Silva, J.B.: (2002): Discussion on "U-Pb Geochronology for the Barreiros tectonised granitoids and Arronches migmatitic gneisses: Tomar Cordoba Shear Zone, East Central Portugal". *Revista Sociedad Geológica de España* 15 (3-4), 247-252.

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