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REPLY

REPLY TO THE DISCUSSION OF "PETROGRAPHY AND GEOCHEMISTRY OF GRANITOID PEBBLES FROM THE OLIGOCENE-MIOCENE DEPOSITS OF THE INTERNAL RIFIAN CHAIN (MOROCCO): A POSSIBLE NEW HYPOTHESIS OF PROVENANCE AND PALEOGEOGRAPHICAL IMPLICATIONS" BY G. CARERI, F. GUERRERA, A. MARTIN-ALGARRA, M. MARTIN-MARTIN, A. MESSINA & V. PERRONE

LISA GIOCONDA GIGLIUTO, DIEGO PUGLISI & GIUSEPPA PUGLISI

Dipartimento di Scienze Geologiche, University of Catania, Corso Italia 55, 95129 Catania, Italy; geolisa@infinito.it, dpuglisi@unict.it, gpuglis@unict.it

Introduction

As we can see, it seems evident that the paper "***Petrography and geochemistry of granitoid pebbles from the Oligocene-Miocene deposits of the Internal Rifian Chain (Morocco): a possible new hypothesis of provenance and paleogeographical implications***" (Gigliuto et al. 2004) brought up some observations within the scientific community working on the Oligocene-Miocene paleogeographical reconstructions of the Betic-Rifian Chain.

The criticized points will be considered below and some of these have already been debated with F. Guerrera and M. Martín-Martín during the process of revision of this paper, when they were invited by the Editorial Office of Geologica Carpathica, at our suggestion, to revise the manuscript as Referees (they were two of the four Referees).

F. Guerrera immediately accepted our manuscript for publication "with minor revisions" as well as the other two Referees, whereas M. Martín-Martín strongly condemned the results obtained and described within the paper up to the end of the revision process, because they are strongly in contrast with the paleogeographical models already existing in the Spanish geological literature.

Now, the number of criticized points increased, probably as a consequence of the increasing number of people added to the two old Referees to form the new team of authors of this Discussion (Careri et al., henceforth A. D., i.e. Authors of the Discussion).

In the following section we will try to answer their critical point, but, firstly, we must thank the Editorial Office of Geologica Carpathica for offering us the possibility to reply to the critical discussion of the A. D. regarding our previous paper.

Response

The first point criticized by the A. D. regards the caption of Fig. 1, a tectonic sketch map of a big area (from Italy to the Straits of Gibraltar), where the different units are not sufficiently subdivided into minor tectonic units. We think that it is a simple tectonic sketch map and an increase of details within this map is not useful because it lies outside the main topic of the paper.

The second criticism of the A. D. concerns the use of the AlKaPeCa term.

This word has firstly been used by Bouillin et al. (1986) to indicate the internal zones of the Alboran-Kabylian-Peloritani-Calabria ensemble as belonging to the southern paleomargin of the European plate. We know that this hypothesis, already suggested by Bouillin (1984), Leblanc & Olivier (1984), Rehault et al. (1984; 1985) and by Dercourt et al. (1986) and successively supported by many other authors (Courme & Mascle 1988; Durand-Delga & Olivier 1988; Dewey et al. 1989; Boccaletti et al. 1990; Weltje 1992), is in contrast with another hypothesis, which considers these terranes as an independent block originally located between the European and African plates.

Nevertheless, we think that to describe also this last hypothesis within a chapter where we must mainly speak about the geological setting and about the objectives of the paper could

represent useless confusion for the reader and, furthermore, we also think that, at the present, this dualism of paleogeographical hypotheses cannot be resolved. The data of this paper, in fact, only represent paleogeographical implications which, perhaps, could emphasize the AlKaPeCa hypothesis of Bouillin et al. (1986) but without supporting it with certainty.

Furthermore, regarding the petrographic characters of the analysed granitoid pebbles, we agree with the A. D. because we also think that these pebbles show very similar petrographic characters to those of the granitoid rocks of the Calabria-Peloritani Arc and we have already described this similarity many times (Puglisi et al. 2001; Zaghloul 2002; Zaghloul et al. 2002; Zaghloul & Puglisi 2003). Nevertheless, at the time of those publications, we had no geochemical data and we could never hypothesize, for these pebbles, a source different from that suggested by previous authors (Martín-Algarra et al. 1995, 2000).

Now, on the basis of these new results and according to many authors, we are strongly convinced that petrographic study alone is not sufficient to obtain all the information necessary to discriminate within the granitoid rock family. For more than 20 years, in fact, it has been common knowledge that the modal data of plutonic rocks are considered an obsolete methodology also for their classification and, consequently, they are not useful as parameters to discriminate within the granitoid rock clan. Geochemical analyses, instead, mainly addressed to detect the trace element contents, represent the best methodologies up to now used to distinguish different granitoid rocks.

As regards the probable "green-schist metamorphic overprint" locally observed in the analysed pebbles, we want to underline that this feature is not exclusive to the acidic granitoid of the Calabria-Peloritani Arc but also occurs in the Iberian Massif (Neiva et al. 1987; Wickham 1987).

Another criticized point regards the probable length of the transport of the well rounded analysed granitoid pebbles (3 to 10 cm sized and never reaching 30 cm of diameter, as mentioned by the A.D.) inferred from some sedimentological characteristics of the conglomerate lithofacies. These conglomerates seem to be linked to debris flows and/or to high concentrated turbidity current processes which do not necessarily imply short transports. The debris flow process, in fact, belongs to the mass transport category of sedimentary processes, whose cannibalistic feeding provokes the re-mobilization and the consequent re-sedimentation of already deposited sediments. So, the total length of the transport must be calculated also taking into account the distance between the source area and the temporary deposition area where the debris flow processes were triggered off. Furthermore, it is common knowledge that the roundness of the pebbles in these deposits is mainly a hereditary characteristic derived from the first transport (source area to temporary deposition area) rather than linked to the distance covered by the debris flow process. This type of sedimentary process, in fact, is not able to produce high degrees of roundness of the clasts because the high content of matrix reduces the impacts between the clasts. Of course, all these considerations regarding the interpretation of the length of transport may be applied to the high concentrated turbidity currents.

Finally, concerning the geochemistry chapter, we must specify that the first assertion of the A. D. is highly inaccurate because it is absolutely incorrect to affirm that our geochemical data have been compared with Hercynian and pre-Hercynian plutonites heterogeneous in composition.

The geochemical data of our analysed granitoid pebbles have been compared with all the compositions available in literature (Peloritani Mts., Sicily: Capo Rasocolmo, Calabria: Aspromonte, Capo Vaticano, Serre and Sila), most of which (about 60 %) mainly shows more than 70 % of SiO_2 and belongs to the subalkaline peraluminous suites (i.e. two mica±cordierite±Al silicate acidic plutonites). In particular, the data of the A. D.'s Table IVb have also been included in our comparison, whereas we excluded all the more basic rocks. A careful control of our selected references, not checked by the A. D., should have surely testified to this choice!

Now, also the new data performed by the A. D. (Table IVa) have been included within the new diagrams (Fig. 1) and our geochemical considerations have not been modified; geochemical characters of the analysed granitoid pebbles, in fact, are always closely compatible with those of the granitoid rocks of the Iberian Massif. The greater part of the acidic plutonites of the Calabria-Peloritani Arc, instead, shows a different chemism (lower Rb and higher Sr and Ba contents).

Furthermore, we think that the Figures 1 and 2 of the A. D. cannot be significant to prove that the analysed granitoid pebbles belong exclusively to the Calabria-Peloritani Arc realm. As already stated above, in fact, the modal data cannot be successfully used to discriminate within the granitoid rock family.

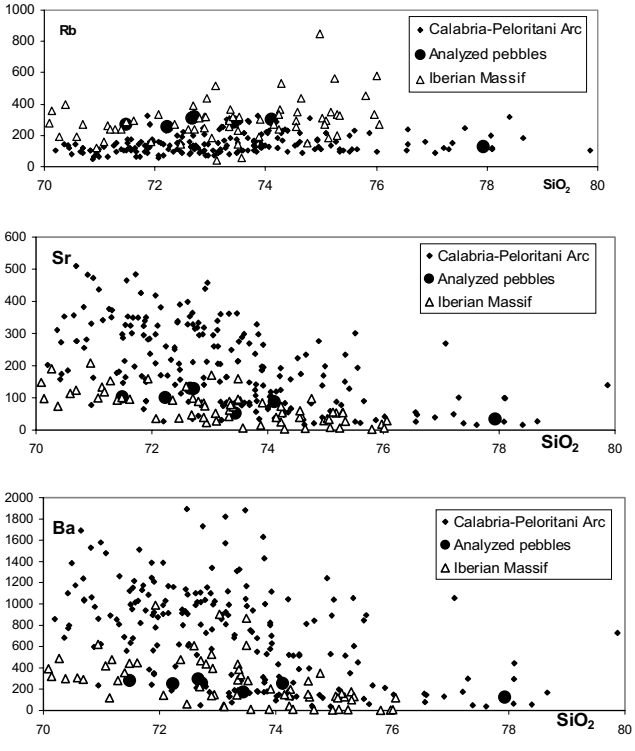

Fig. 1. Diagrams showing the Rb, Sr and Ba ppm contents vs. the SiO_2 weight percentages.

Similarly, like many other authors, we also think that to use the major-oxide compositions as discriminant parameters represents an obsolete methodology; so, if we include within the diagrams of Figure 3 and 4 of the A. D. also the chemical data of the peraluminous plutonites of the Iberian Massif, they will fall in the same area.

Furthermore, the high Al_2O_3 contents and the A/CNK > 1 ratio of the studied pebbles allow us to exclude their belonging to I-type granitoids (typically metaluminous), thus confirming the inadequacy of the diagrams used by the A. D. in their Figures 3 and 4.

In the Figures 5 and 6 of the A. D. it is difficult to understand why the data of the Sila plutonites have not been differentiated! In these diagrams, in fact, the data of two different plutonite suites of the Sila Batholith have been plotted: (1) pyroxene+amphibole+biotite-bearing gabbros or diorites to granodiorites and (2) two mica+cordierite+Al-silicate-bearing granodiorites to leucomonzogranites. In our Figure 2, instead, we compare the analysed granitoid pebbles only with the geochemical data of the Sila plutonites available in literature (Messina et al. 1991a,b, 1993), showing a SiO_2 content > 70 %. Also in this diagram the studied pebbles are well characterized by higher contents of Rb, which strongly mark the difference

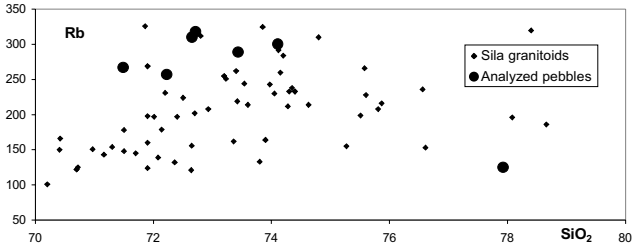

Fig. 2. Rb vs. SiO_2 diagram. Diamond — Sila granitoids, dots — pebbles.

existing between the acidic plutonites of the Sila Batholith and our granitoid pebbles.

Finally, concerning the trace elements, an enrichment of light REE coupled with a depletion of heavy REE and with a negative Eu anomaly is also typical of the Iberian Massif plutonites (Rottura et al. 1989; Holtz & Barbey 1991).

The comparison of a very large number of geochemical data allowed us to characterize the differences between the Calabria-Peloritani Arc and the Iberian Massif peraluminous and metaluminous plutonites as mainly related to the average content of Sr, Rb and Ba.

These differences (higher Rb and lower Sr and Ba contents — Iberian Massif; lower Rb and higher Sr and Ba contents — Calabria-Peloritani Arc), probably connected to very interesting and complicated petrogenetic histories of the two orogenic complexes, can be very useful to understand the source of the analysed granitoid pebbles.

Nevertheless, the A. D. persist to consider the analysed granitoid pebbles as belonging to the Calabria-Peloritani Arc on the basis of very debatable arguments and they reject the evidence of the differences existing between these two big orogenic complexes, thus showing that they have a limited open-mindedness about other opinions and a strong will to reject them without sound arguments.

Conclusions

We are conscious that a new hypothesis of provenance is very difficult to be supported with the small number of analysed granitoid pebbles; for this reason we entitled our paper as "*... a possible new hypothesis of provenance and paleogeographical implications*" in order to specify that the obtained data can only represent suggestions rather than a new paleogeographical model.

Otherwise, we also think that the suggestion, today, of an alternative provenance could be important in the future (i) for the researchers which later, by increasing the number of the available data, could propose a different paleogeographical model, and (ii) for the authors which first proposed that suggestion and will be cited.

Thus, we hope that these our geochemical results could represent a new input of research aimed to detect the paleogeographical scenario responsible for the feeding of the analysed granitoid rocks. We think, in fact, that only increasing the number of geochemical analyses will make it possible to obtain paleogeographical "reconstructions" rather than "implications" and to close this scientific controversy.

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