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DISCUSSION

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 L.G. GIGLIUTO, A. OUAZANI-TOUHAMI, D. PUGLISI, G. PUGLISI & M.N. ZAGHLOUL

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Discussion of the paper by L.G. GIGLIUTO et al. published in: *Geologica Carpathica* 55, 3, 261–272 (2004)

The Betic-Rif Chain represents the westernmost segment of the Mediterranean Alpine orogenic system, formed, in the Late Cretaceous to the Middle Miocene time span, by the closure of oceanic belts and the collision among Iberia and Africa plates and a Mesomediterranean Microplate (Guerrera et al. 1993; Michard et al. 2002). The chain consists of Internal, External and Flysch Domains, with the latter tectonically sandwiched between the two former in both branches of the orogen. From bottom to top the Internal Units are constituted by the Nevado-Filábride (only in the Betics), the Alpujarride-Sebtide, the Malaguide-Ghomaride and the Rondaide-Rifian “Dorsale” Complexes. In the Flysch Complex, internal Mauretanian Units and external Massylian-Numidian Units have been distinguished.

In the marine sedimentary successions of the Malaguide-Ghomaride, Rondaide-Rifian “Dorsale” and Mauretanian Units a marked increase in terrigenous supply occurs from the Late Oligocene. This terrigenous acme was coeval with regional metamorphism, tectogenesis in deep crustal levels of the orogen and, finally, collision against the External Domains. The Tertiary clastic Oligo-Miocene sediments of the Internal Domain are arranged into two sedimentary cycles, bounded by unconformities: the Oligo-Aquitanian Ciudad Granada-Fnideq Group, transgressive only above the Malaguide-Ghomaride Units, and the lower-middle Burdigalian Viñuela-Sidi Abdeslam Group, transgressive above the Malaguide-Ghomaride and highest Alpujarride-Sebtide Units. At the same time, thick and continuous immature turbidite successions were deposited in the Mauretanian Zone of the Flysch Domain, as lateral equivalent of the Ciudad Granada-Fnideq deposits.

These Oligo-Miocene clastic formations include magmatic (granitic) and metamorphic (orthogneissic) pebbles, the source of which represents an intriguing problem because similar granitic plutonites are lacking in the outcropping Betic-Rif Orogen (Martín-Algarra et al. 2000 and references therein). Clasts of granitoids in the Fnideq Fm. have been recognized for a long time and interpreted as derived from Alpujarride-Sebtide metamorphic complexes of the Internal Domain (Olivier et al. 1979). However, as pointed out by Martín-Algarra et al. (2000), such a provenance is unlikely because, at that time (Oligocene-Early Miocene), the lower units of the Internal Domains were tectonically underlying the Malaguide-Ghomaride Complex and being subjected to Alpine metamorphism, as shown by an increasing amount of radiometric data on (see Zeck 2004, and references therein, for a recent revision). In fact, after analysing 176 pebbles of both magmatic and metamorphic rocks sampled in the Ciudad Granada-Fnideq deposits all around the Gibraltar Arc, Martín-Algarra et al. (2000) recognized magmatic and metamorphic lithotypes with lithological and structural characters different to the Alpujarride-Sebtide rocks and similar to those known for lithotypes of some units of the Calabria-Peloritani Arc. Consequently, they regarded as the source area of the pebbles a lost realm similar to the Calabria-Peloritani Arc, successively destroyed by erosion or buried under the Alboran Sea. Such realm was contiguous to the Ghomaride-Malaguide Sub-domain and was also characterized by Paleozoic basements and Meso-Cenozoic covers similar, but not necessarily identical, to those of the Malaguide-Ghomaride Complex, as testified by the presence of sedimentary and epimetamorphic pebbles reflecting the typical lithologies of the Ghomaride-Malaguide successions.

However, after studying the petrographic and geochemical features of seven pebbles of granitoids sampled from upper Oligocene to lower Miocene conglomerates of the Fnideq Fm. (three pebbles) and of the lower portion of the Beni Ider Flysch, which represents the uppermost formation of the Mauretanian Beni Ider Unit (four samples), Gigliuto et al. (2004) believe that their new data open again the discussion concerning the source areas of the granitoid clasts found in the Tertiary deposits of the Ghomaride and Maghrebian Flysch Basin Domains. Two new alternatives are proposed:

— if these clasts come from a lost realm, this realm should be similar to the Iberian Massif rather than the whole Calabria-Peloritani Arc and Kabylias;

— the pebbles of granitoids come directly from the Iberian Massif, whereas the sedimentary clasts associated in the same conglomerate levels probably come from the Prebetic covers. The Iberian Massif and the Prebetic Zone should provide clastic supply to satellite basins located on the Ghomaride Units (Fnideq Fm.) and also to the Beni Ider Flysch Basin, located south of the Ghomaride Sub-domain in the paleogeographical scheme of these authors. Consequently, the paleogeographical scenario should be completely different from those up to now proposed for the Betic-Rif Chain.

We must emphasize that the recognition and characterization of conglomerate levels with granitoid and sedimentary pebbles in the Beni Ider Flysch Fm. represents a very important recent datum (Puglisi et al. 2001; Zaghloul 2002; Zaghloul et al. 2002), but we completely disagree with the interpretations of Gigliuto et al. (2004) as regards the interpretation of their geochemical data, the origin of the clastics supplied to the Fnideq and Beni Ider Basins, the new paleogeographical scenario and the consequent evolution of the Betic-Rif Chain.

Firstly, it is very difficult to accept a tectonic scheme of the western Mediterranean (Figure 1 of Gigliuto et al. 2004) in which: 1) the whole Alps are indicated as made of *"Units of the Spanish-European paleomargin deformed during the Alpine Orogeny"*; 2) the Prebetic, Subbetic and Campo de Gibraltar Flysch Units are indicated as *"African Units deformed during the Apenninic-Maghrebian Orogeny"*; 3) the front of the Helvetic-Dauphinois Units of the Alps and the northern front of the Pyrenees are considered as *"Pennidic front"*; and 4) the front of the Betic Cordilleras is reported as *"front of the Apenninic-Maghrebian Chain"*. Similarly, taking into account the tectonic and paleogeographical implications shown in this paper, it seems excessively simplistic to consider, without discussion, the Internal Domains of the Betic-Rif Chain as the southern margin of the European plate, so fully neglecting most recent and ancient literature which regards them as an independent block (Andrieux et al. 1970; Wildi 1983; Bouillin et al. 1986; Doglioni 1992; Dercourt et al. 1993; Guerrera et al. 1993; Puga et al. 1995; Sanz de Galdeano 1997; Michard et al. 2002; among many others).

As regards petrographic data, the plutonic pebbles analysed by Gigliuto et al. (2004) "*can be ascribed to the two-mica, cordierite-bearing monzogranite up to leuco-monzogranite clans*", and "*show a massive fabric, an inequigranular structure, mainly medium- (0.25-0.5 mm) to fine-grained and a hypidiomorphic to subhypidiomorphic texture*". Furthermore, the authors recognize in these samples "*very sporadic traces of a probably green-schist metamorphic overprint have been recognized. An association of albite + white mica + epidote + chlorite, that is not pervasive and does not obliterate the original magmatic texture, is evidence of this*". Even if their number is very scanty for a reliable comparison, these features are petrographically and structurally similar to those of acidic peraluminous types (two mica±cordierite±Al-silicate monzogranites and leucomonzogranites) which are common in the Calabria-Peloritani Arc (Sila and Stilo Batholiths and Aspromonte Unit plutonic stocks) constituting minor plutonic bodies and felsic dykes, representing the latest intrusions (Messina et al. 1991a,b, 1993, 1994, 1996; Ayuso et al. 1994). Likewise, the studied pebbles of Gigliuto et al. (2004) are structurally and compositionally similar to two of the four plutonic clusters recognized by Martín-Algarra et al. (2000) in the pebbles of the Fnideq Fm. The strong similarities between Rifian plutonic pebbles and Calabrian plutonites are shown by modal data (Tables I and II) and Q-A-P diagram (I.U.G.S. 1973; Figs. 1 and 2), demonstrating that the studied samples are similar to the most acidic peraluminous members of the Calabria-Peloritani Arc magmatic suites and to the most acidic samples recognized by Martín-Algarra et al. (2000) in the Fnideq Fm.

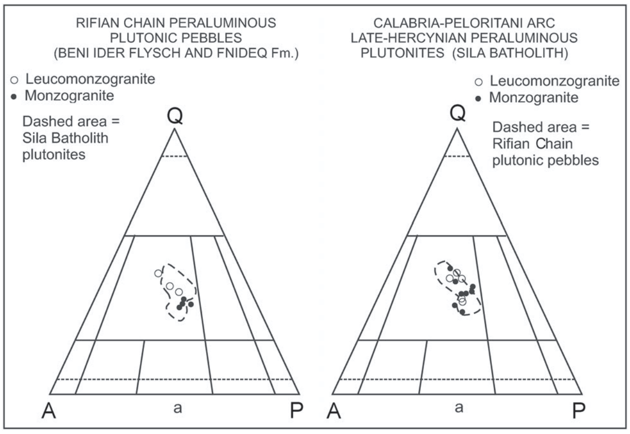

Fig. 1. Modal Q-A-P diagrams (I.U.G.S. 1973) of the Rifian Chain peraluminous plutonic pebbles (after Gigliuto et al. 2004; Table I) and of the Calabria-Peloritani Arc late-Hercynian peraluminous plutonites (after Messina et al. 1993 and new data of Table II).

Table I: Modal data of Beni Ider Flysch and Fnideq Fm. two mica±cordierite-bearing plutonic pebbles*.

	Monzogranite				**Leucomonzogranite**		
Sample	**AC$_8$**	**CR$_1$**	**AC$_{22}$**	**CR$_8$**	**CR$_{10}$**	**VU$_4$**	**BM$_{12}$**
Quartz	29.7	32.3	28.5	31.9	34.3	35.4	41.1
Plagioclase	33.6	31.1	29.8	24.1	28.1	23.7	17.4
K-feldspar	23.2	26.2	27.0	27.3	24.9	28.3	29.9
Biotite	7.5	4.9	9.7	10.4	3.8	3.5	1.9
Musovite	4.1	3.7	3.1	4.3	7.7	6.6	8.1
Cordierite	0.8	0.5	0.7	0.5	-	-	-
Accessories	0.4	0.2	-	0.3	-	0.8	0.7
Opaques	0.7	1.1	1.2	1.2	1.2	1.7	0.9
Tot.	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*After Gigliuto et al. (2004)

Table II: Modal data of representative late-Hercynian Sila Batholith two mica±cordierite±Al-silicate-bearing plutonites*.

	Monzogranite									**Leucomonzogranite**							
Sample$^\#$	**PA95$^+$**	**DT17**	**DT44**	**FS23**	**DT25**	**FS28**	**FS42**	**PA122**	**FS25**	**PA20**	**PA189**	**DT54**	**PA214$^+$**	**PA108$^+$**	**PA110**	**PA187**	**PA5$^+$**
Quartz	29.3	36.2	37.4	34.0	35.3	33.0	30.0	41.9	44.5	37.8	35.7	32.7	32.4	35.5	41.0	45.0	42.9
Plagioclase	31.6	31.4	30.1	29.9	28.5	27.9	25.4	24.8	19.3	35.3	30.9	29.6	29.5	27.5	26.3	24.4	21.5
K-feldspar	29.8	24.3	21.6	21.9	27.1	23.9	30.1	28.6	27.5	24.8	29.3	27.8	27.5	27.5	24.5	26.7	30.4
Biotite	5.2	3.8	3.3	5.6	4.3	3.9	5.3	4.5	4.6	1.8	2.0	0.6	2.7	2.8	1.8	1.4	2.0
Muscovite	3.7	4.2	7.3	8.3	4.7	11.1	9.1	0.2	3.7	0.3	2.1	9.3	7.2	4.9	6.2	1.8	2.4
Cordierite	tr	-	0.3	0.3	tr	tr	tr	tr	tr	tr	tr	tr	0.5	1.6	-	tr	0.5
Andalusite	tr	tr	tr	-	tr	0.2	-	tr	0.2	-	-	tr	tr	tr	-	-	0.3
Sillimanite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	tr	-
Accessories°	0.4	0.1	tr	tr	0.1	tr	0.1	tr	0.2	tr	tr	tr	tr	0.2	tr	tr	tr
Opaques°°	tr	-	tr	-	tr	-	-	-	-	-	-	-	0.2	tr	0.2	-	-
Tot.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* After Messina et al. (1993); $^\#$ PA — Patire, DT — Difesella del Trionto, and FS — Fossiata plutonites; $^+$ New data; ° Apatite+Zircon±Monazite±Tourmaline; °° Magnetite

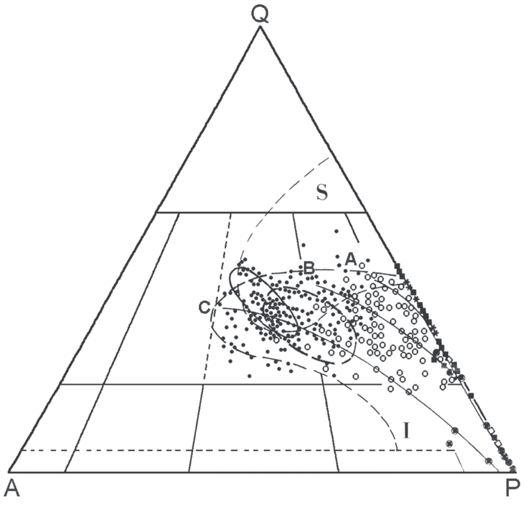

Fig. 2. Modal Q-A-P diagrams (I.U.G.S. 1973) of the Sila Batholith plutonic suite (after Messina et al. 1993, 1994 and new data of Table II) and compared Rifian Chain peraluminous plutonic pebbles (after Gigliuto et al. 2004, continuous line; after Martín-Algarra et al. 2000, dashed line). *Legend:* squares, asterisks and open circles — Sila Batholith pyroxene±amphibole±biotite-bearing gabbros to granodiorites; dots — Sila Batholith two mica±cordierite±Al-silicate-bearing granodiorites to leucomonzogranites; A, B and C — Sila Batholith calc-alkaline different K-content trends (after Messina et al. 1991a, C also corresponds to the granodioritic medium-K trend of Lamayre & Bowden 1982); S and I — S- and I-type granitic fields of Chappell & White (1982).

As regards geochemical data (Table III), the seven less weathered plutonic pebbles of Gigliuto et al. (2004) indicate major element oxides typical of felsic (SiO_2 = 71.49–77.93 %; MgO = 0.13–0.63 % and FeO_{tot} = 0.42–2.17 %) peraluminous (Al_2O_3 = 12.06–14.68 %; A/CNK = 1.0–1.3), and "calc-alkaline" (CaO = 0.38–1.09 %; K_2O+Na_2O = 7.37–9.18 %; TiO_2 = 0.05–0.28 %) intrusives. The highly evolved magmatic character of these acidic plutonic pebbles is confirmed by trace element data, which indicate low Sr (34–130 ppm) and Ba (122–296 ppm) contents and high Rb (125–318 ppm) values, in addition to an enrichment of light rare earth elements (REE) and a depletion of heavy REEs with a negative Eu anomaly. This latter is emphasized in their BM$_{12}$ leucomonzogranite sample. According to these authors, the Sr, Rb and Ba values are very different from those known for late-Hercynian granitoids of the Calabria-Peloritani Arc and Kabylias, Pan-African plutonites of Algeria and Hercynian and pre-Hercynian plutonites of both the High Atlas and Anti-Atlas, and "*show strong geochemical affinities only with the Hercynian granitoids of the Iberian Massif (115 analyses from central Spain and from northern and central Portugal)*" (see also Fig. 8 of Gigliuto et al. 2004). But in our opinion, this discrepancy results only because the authors compare chemical data of many Hercynian and pre-Hercynian plutonites which are heterogeneous in size, texture and composition, and because they consider all the available data for intrusives of the Calabria-Peloritani Arc, whose composition ranges from granodioritic up to melatonalitic, whereas geological, petrographic and modal data indicate

Table III: Chemical data of Beni Ider Flysch and Fnideq Fm. two mica±cordierite-bearing plutonic pebbles*.

	Monzogranite				**Leucomonzogranite**		
Sample	**CR$_8$**	**CR$_1$**	**AC$_{22}$**	**AC$_8$**	**CR$_{10}$**	**VU$_4$**	**BM$_{12}$**
SiO_2 (wt. %)	72.23	72.66	73.44	74.11	71.49	72.72	77.93
TiO_2	0.26	0.20	0.30	0.13	0.28	0.16	0.05
Al_2O_3	14.68	14.29	13.67	14.22	14.48	14.21	12.06
Fe_2O_3	1.93	1.58	2.17	0.69	1.93	1.70	0.42
MnO	0.02	0.02	0.03	0.01	0.02	0.02	0.01
MgO	0.63	0.41	0.56	0.19	0.61	0.52	0.13
CaO	1.09	0.73	0.73	0.56	1.04	0.87	0.38
Na_2O	3.13	2.83	2.98	3.29	2.99	2.79	3.49
K_2O	4.58	5.29	4.76	5.69	4.82	5.02	4.88
P_2O_5	0.17	0.15	0.18	0.23	0.17	0.20	0.02
LOI	1.36	1.26	1.15	0.82	1.26	1.77	0.65
Tot.	100.08	99.42	99.97	99.94	99.09	99.98	100.02
Sc (ppm)	4	3	5	2	4	2	3
Ga	19	21	20	16	19	20	19
Rb	257	310	289	300	267	318	125
Sr	101	130	52	88	102	128	34
Y	11	16	20	5	11	12	48
Zr	118	126	106	57	115	103	74
Nb	12	15	14	15	12	12	14
Sn	9	18	9	12	8	17	3
Cs	22.3	32.3	30.7	11.9	21.4	36.9	0.9
Ba	249	296	170	253	279	256	122
La	21.2	27.9	22.8	9.4	22.4	19.1	14.0
Ce	44.3	54.9	47.8	19.5	49.3	37.7	44.9
Nd	19.8	23.3	21.4	8.1	21.5	15.9	14.4
Eu	0.54	0.58	0.46	0.49	0.57	0.50	0.13
Tb	0.4	0.6	0.7	0.3	0.5	0.4	1.1
Yb	1.0	1.7	2.0	0.5	1.0	1.0	4.7
Lu	0.15	0.23	0.27	0.07	0.15	0.14	0.68
Hf	3.3	3.6	3.0	2.0	3.3	2.9	3.7
Ta	1.9	3.0	1.9	3.9	1.9	2.7	3.8
Th	12.0	12.8	11.4	4.9	12.5	9.8	19.0
U	2.2	3.8	2.3	1.8	2.2	3.1	2.2

* After Gigliuto et al. (2004)

that their seven pebbles are monzogranites and leucomonzogranites. A meaningful geochemical comparison, therefore, must be performed only with sub-alkaline, peraluminous (cordierite-bearing) monzogranite and leucomonzogranite plutonites recognized in the Calabria-Peloritani Arc.

When the chemical comparison is made on this new basis, the major element variations of the pebbles of Gigliuto et al. (2004; Table 3) constantly plot overlapped to the compositional field of the Sila monzogranite and leucomonzogranite peraluminous plutonites (Figs. 3 and 4). In the Na_2O vs. K_2O (Fig. 3) and FeO vs. CaO (Fig. 4) diagrams, the studied pebbles plot in the I-type field, like the Sila intrusives, marking a different character from that indicated by Gigliuto et al. (2004). Similarly, variations of Ba, Rb and Sr contents (Figs. 5 and 6) also confirm the close chemical affinity between Rifian pebbles and peraluminous Calabrian plutonites and, actually, the pebbles exhibit high Rb and low Sr and Ba contents on the average (Figs. 5 and 6). The BM$_{12}$ sample of Gigliuto et al. (2004) shows lower Ba and Rb values than the other six plutonic pebbles and the Sila Batholith peraluminous types, indicating for this sample a late-stage fluid-rock interaction related to hydrothermal alteration processes.

The close chemical affinity between Rifian pebbles and Calabrian plutonites is also confirmed by the REE data (Tables III, IVa and IVb). Chondrite-normalized REE plots of Rifian pebbles and Calabrian plutonites (Messina et al. 1991b; Ayuso et al. 1994) show the similar range and step of patterns (cf. Fig. 7 of this paper and Fig. 6 of Gigliuto et al. 2004). They are characterized by a progressive light REE enrichment and varying degrees of heavy REE depletion in addition to an increase in the negative Eu anomaly going towards more felsic rocks. Leucomonzogranites show a large Eu depletion evident both in the pebble sample BM$_{12}$ and in the felsic types of the Sila Batholith.

As regards the sedimentological characters of the conglomerate intervals from which the analysed samples were collected, we agree with Gigliuto et al. (2004) who consider these conglomerates as "*indicative of debris flows and/or highly concentrated turbidity current processes*", so implicitly admitting a short transport from the source areas. However, the authors neither take into account nor discuss the essential parameter represented by the high distance (a thousand of kilometers) occurring between the considered source areas (Central-Northern Iberian Meseta, Prebetic) and the depositional ones (Fnideq and Beni Ider Basins). In fact, this distance is not compatible either with the big dimensions of the granitoid pebbles (up to 30 cm sized) or with mass-flow transport processes and the presence of olistoliths. Moreover, the authors should explain how big plutonic clasts derived from the Central-Northern Iberian Meseta and calcareous clasts derived

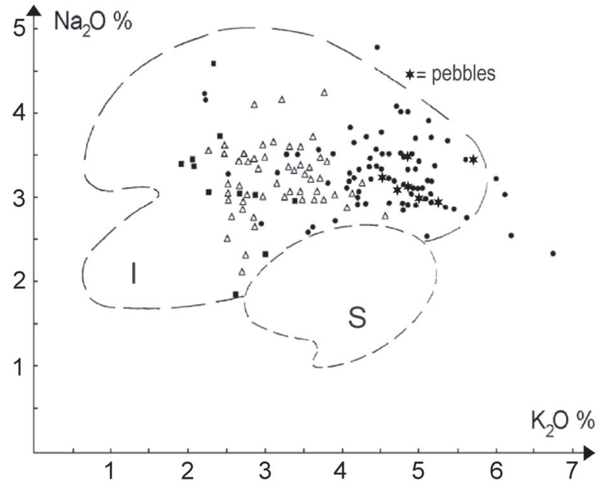

Fig. 3. Na_2O vs. K_2O diagram for the Sila Batholith available data (after Messina et al. 1991b, 1993; Ayuso et al. 1994 and new data. Representative analyses Tables IVa and IVb) and pebbles of Gigliuto et al. (2004; Table 3). *Legend:* squares and triangles — Sila Batholith biotite±amphibole-bearing diorite to granodiorite plutonites; dots — Sila Batholith two mica±cordierite±Al-silicate-bearing granodiorite to leucomonzogranite plutonites; stars — monzogranite to leucomonzogranite pebbles of Gigliuto et al. (2004); S and I — S- and I-type granitic fields of Chappell & White (1982).

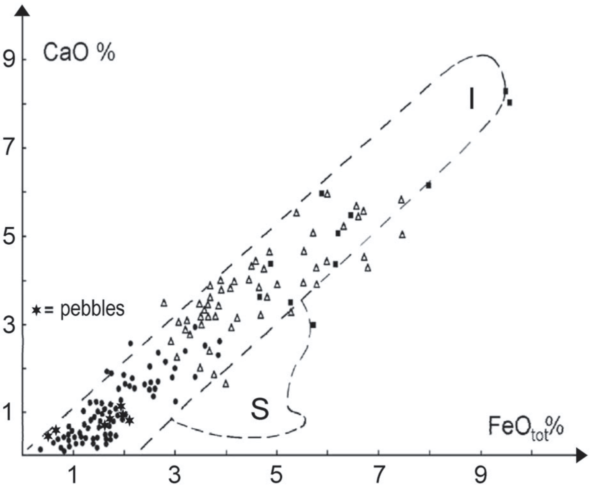

Fig. 4. FeO_{tot} vs. CaO diagram for the Sila Batholith available data (after Messina et al. 1991b, 1993; Ayuso et al. 1994 and new data. Representative analyses in Tables IVa and IVb) and pebbles of Gigliuto et al. (2004; Table 3). *Legend:* squares and triangles — Sila Batholith biotite±amphibole-bearing diorite to granodiorite plutonites; dots — Sila Batholith two mica±cordierite±Al-silicate-bearing granodiorite to leucomonzogranite pluronites; stars — monzogranite to leucomonzogranite pebbles of Gigliuto et al. (2004); S and I — S- and I-type granitic fields of Chappell & White (1982).

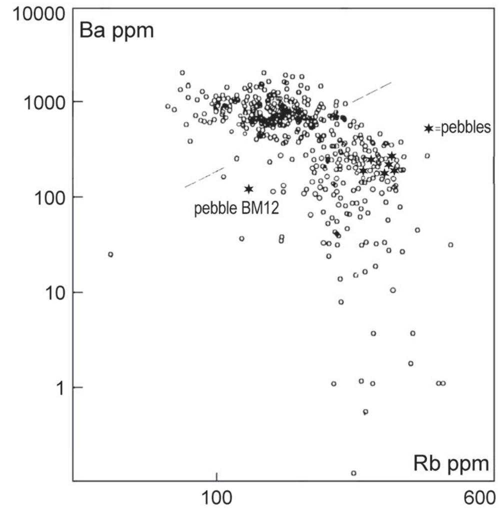

Fig. 5. Rb vs. Ba diagram for the Sila Batholith available data (after Messina et al. 1991b, 1993; Ayuso et al. 1994 and new data. Representative analyses in Tables IVa and IVb) and pebbles of Gigliuto et al. (2004; Table 3). *Legend:* open circles — Sila Batholith gabbros to leucomonzogranites plutonic suite; stars — monzogranite to leucomonzogranite pebbles of Gigliuto et al. (2004). Dashed line defines the limit of high Ba values for the Sila Batholith two mica±cordierite±Al-silicate-bearing granodiorites to leucomonzogranites.

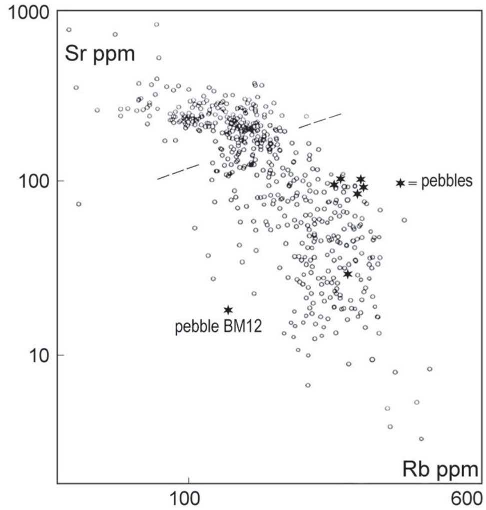

Fig. 6. Rb vs. Sr diagram for the Sila Batholith available data (after Messina et al. 1991b, 1993; Ayuso et al. 1994 and new data. Representative analyses in Tables IVa and IVb) and pebbles of Gigliuto et al. (2004; Table 3). *Legend:* open circles — Sila Batholith gabbros to leucomonzogranites plutonic suite; stars — monzogranite to leucomonzogranite pebbles of Gigliuto et al. (2004). Dashed line defines the limit of high Sr values for the Sila Batholith two mica±cordierite±Al-silicate-bearing granodiorites to leucomonzogranites.

from the Prebetic (that is, from the proximal Southern Iberian Paleomargin) would reach paleographical domains as internal as the Mauritanian sector of the Flysch Basin and as the Ghomarides, without leaving any important siliciclastic nor calciclastic contribution derived from these zones in the Subbetic domain, which represents the distal part of the Southern Iberian paleomargin and where such provenances have never been reported. The lithological characters of the sedimentary clasts of the Beni Ider and Fnideq deposits, on the contrary, are fully similar to those of the Ghomaride-Malaguide basement and cover. In fact, rocks typical or exclusive of these latter units, as Lower Paleozoic slates, Paleozoic limestones, radiolarites and

Table IVa: Chemical data of representative late-Hercynian Sila Batholith two mica±cordierite±Al-silicate-bearing plutonites*.

	Monzogranite									Leucomonzogranite							
Sample$^{\#}$	**FS42**	**FS23**	**FS25**	**DT25**	**FS28**	**PA95^{+}**	**DT17**	**DT44**	**PA122**	**PA108^{+}**	**PA214^{+}**	**DT54**	**PA20**	**PA187**	**PA189**	**PA110**	**PA5^{+}**
SiO_2 (wt.%)	71.86	72.80	73.23	73.40	73.85	74.05	74.12	74.28	75.27	74.15	74.35	74.63	75.51	75.87	76.56	78.08	78.66
TiO_2	0.25	0.20	0.25	0.19	0.17	0.21	0.19	0.11	0.20	0.17	0.09	0.04	0.10	0.11	0.07	0.05	0.06
Al_2O_3	14.68	14.63	13.72	13.61	14.02	14.09	13.65	13.49	12.50	14.23	13.29	13.53	12.19	13.09	12.64	11.89	11.87
Fe_2O_3	1.40	0.98	0.80	0.50	1.01	0.69	1.12	1.04	0.77	0.55	0.57	0.87	0.89	1.21	0.73	0.74	0.48
FeO	0.40	0.85	1.20	1.20	0.70	1.30	0.60	0.45	1.20	1.20	0.75	0.30	0.45	0.35	0.45	0.30	0.55
MnO	0.01	0.03	0.03	0.04	0.03	0.06	0.03	0.05	0.04	0.05	0.04	0.07	0.03	0.04	0.06	0.03	0.02
MgO	0.37	0.31	0.36	0.55	0.31	0.75	0.52	0.22	0.79	0.66	0.35	0.18	0.35	0.39	0.24	0.22	0.30
CaO	0.37	0.47	0.86	0.61	0.38	0.85	0.42	0.65	0.94	0.77	0.47	0.28	0.40	0.23	0.43	0.51	0.30
Na_2O	2.77	2.85	2.87	3.16	2.95	2.87	3.25	3.14	2.79	2.84	3.06	3.69	3.02	3.10	3.40	3.07	2.84
K_2O	5.60	4.96	4.92	5.11	5.07	4.73	4.83	4.67	4.74	5.30	4.87	4.49	4.97	4.80	4.75	4.06	5.10
P_2O_5	0.29	0.20	0.15	0.11	0.21	0.10	0.19	0.12	0.05	0.10	0.12	0.09	0.05	0.05	0.04	0.13	0.04
LOI	1.23	1.23	1.07	0.95	1.04	0.85	1.09	0.94	0.60	0.89	0.99	1.02	0.95	0.81	0.63	0.71	0.65
Tot.	99.23	99.51	99.46	99.43	99.74	100.85	100.01	99.16	99.89	101.18	98.95	99.20	98.91	100.05	100.0	99.79	100.87
Cu (ppm)	2	3	2	-	4	-	5	32	-	1	-	26	1	-	-	-	-
Zn	49	41	43	39	35	47	27	16	27	28	17	20	36	16	16	16	38
As	3	7	4	1	1	1	2	3	3	2	4	2	10	1	-	3	-
Rb	326	312	251	262	325	230	292	212	155	260	238	214	199	216	236	196	186
Sr	66	44	75	51	35	118	37	47	78	120	55	17	26	31	26	26	27
Y	49	18	22	26	18	26	17	16	41	22	17	15	41	32	44	11	33
Nb	19	19	15	13	18	9	16	10	8	9	10	9	9	10	9	7	7
Sn	9	8	7	5	9	5	7	13	-	-	3	11	1	-	3	-	2
Sb	-	-	-	4	1	-	1	3	-	2	1	2	6	1	1	4	-
Ba	243	224	337	281	178	317	223	121	350	244	130	28	110	211	78	63	167
La	21	18	62	-	14	-	24	22	31	-	8	9	37	7	19	22	-
Ce	69	53	79	36	52	56	65	-	83	52	33	35	49	45	57	36	75
Nd	25	18	28	25	16	38	15	-	64	22	20	5	32	28	36	28	30
Pb	23	22	24	23	21	21	22	21	24	21	18	18	27	19	25	16	23

* After Messina et al. (1993); # PA — Patire, DT — Difesella del Trionto and FS — Fossiata plutonites; + New data

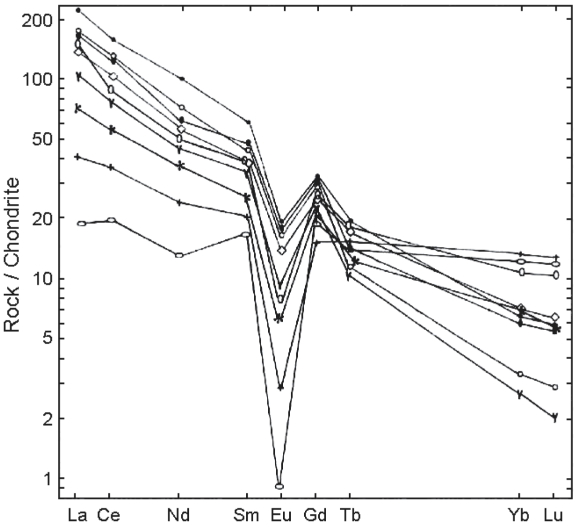

Fig. 7. Chondrite normalized REE patterns for the Sila Batholith two mica±cordierite±Al-silicate-bearing monzogranite and leucomonzogranite bodies and dykes after Messina et al. (1991b) and Ayuso et al. (1994), also including compared samples of Table IVb. Normalizing data based on the CI-chondrites after Anders & Ebihara (1982).

Table IVb: Chemical data of representative late-Hercynian Sila Batholith two mica±cordierite±Al-silicate-bearing plutonites.

	Leucomonzogranite				
Sample	**BD75***	**BD 356****	**BD 138****	**BD77***	**BD78***
SiO_2 (wt. %)	71.90	71.90	73.20	74.20	78.40
TiO_2	0.20	0.20	0.05	0.08	0.07
Al_2O_3	14.30	14.30	14.70	13.40	13.90
Fe_2O_3	0.06	0.06	0.36	0.09	0.10
FeO	1.46	0.46	1.58	0.86	0.58
MnO	0.03	0.03	0.03	0.03	0.04
MgO	0.50	0.50	0.15	0.33	0.10
CaO	0.88	0.88	0.50	0.42	0.44
Na_2O	3.42	3.42	3.68	3.94	3.58
K_2O	4.79	4.79	4.92	4.80	4.70
P_2O_5	0.20	0.20	0.27	0.11	0.05
L.O.I.	1.09	1.09	1.16	0.87	0.77
Total	98.83	96.74	100.60	99.13	102.73
Sc (ppm)	3.7	3.7	2.3	3.5	1.2
Cr	2.9	2.9	< 2	2.1	2.7
Co	1.8	1.8	0.6	0.61	0.19
Ni	5	3	5	8	5
Cu	7	7	6	6	7
Zn	80	80	23	23	20
As	0.5	0.3	0.3	0.8	0.7
Rb	269	269	255	284	320
Sr	90	90	31	28	16
Y	23	23	15	26	29
Zr	113	-	-	62	50
Nb	15	15	13	13	8
Mo	2	1	0.4	2	3
Sb	0.05	0.03	0.17	0.04	0.06
Cs	3.7	-	-	5.9	3.9
Ba	349	339	129	161	57
La	24	23.9	5.35	13.2	5.9
Ce	47	47	10.50	30	16
Nd	23	23.4	4.70	14.2	8.1
Sm	5.2	5.17	1.48	4.4	3.5
Eu	0.51	0.51	0.22	0.2	0.06
Gd	5.6	5.60	2	4.1	5.2
Tb	0.64	0.64	0.25	0.74	0.67
Yb	1.5	1.55	0.76	2.8	3
Lu	0.20	0.20	0.10	0.41	0.43
Hf	3.2	3.22	1.65	2.2	2.5
Ta	1.8	1.83	2.99	2.2	1.5
Th	12	12.80	2.68	9.4	7.4
U	3.5	3.51	1.40	5.6	8.4

* After Messina et al. (1991b); ** After Ayuso et al. (1994)

sandstones, Mesozoic and nummulite limestones, Verrucano-like red-quartzose sandstones, are abundant.

Finally, taking into account available regional geological data we believe that the paleogeographical scenario suggested by Gigliuto et al. (2004) is unacceptable because these authors do not consider:

— data from Martín-Algarra et al. (2000), concerning 176 magmatic and metamorphic clasts for the only Fnideq Fm., which indicate that the granitoids affected by extensive or partial Alpine overprint amount to 30.7% of the clasts. These clasts cannot obviously come from the Iberian Meseta and this datum is fully neglected, even if *"very sporadic traces of a probably green-schist metamorphic overprint"* have also been recognized in the samples studied by Gigliuto et al. (2004);

— the Iberian Massif during the Late Oligocene and the Early Miocene was the foreland of an incipient foreland basin. It represented a passive margin without an important relief or important erosion;

— as regards the conglomerate levels of the Beni Ider Flysch, if located in the southernmost position as supposed by the authors, the Ghomaride and "Dorsal" Zones should have constituted a further great obstacle to the supply for the basin.

In conclusion, we reject the results of the paper of Gigliuto et al. (2004) because the pointed out geochemical differences between the studied samples and the granitoids outcropping in the Calabria-Peloritani Arc–Kabylias do not exist, if the granitoid pebbles are compared only with the peraluminous cordierite-bearing monzogranites and leucomonzogranites of the Calabria-Peloritani Arc. Furthermore, the hypothesized supply of the pebbles, recognized in the Fnideq and Beni Ider Fms., from the Iberian Meseta and the Prebetic Zone cannot be taken into consideration because it clashes with insurmountable difficulties. These are represented by the sedimentological features of the conglomerate levels, by the lithological characters of the metamorphic and sedimentary clasts occurring in the same conglomerate levels and by a lot of regional data concerning the paleogeography and the tectono-sedimentary evolution of the domains involved in the building of the Betic-Rif Chain during the Late Oligocene–Aquitanian. On the contrary, as regards the source areas of the pebbles occurring in the Fnideq Fm. we confirm the conclusions of Martín-Algarra et al. (2000). In this paper all data agree with a continental crust realm similar to the whole Calabria-Peloritani Arc–Kabylias with a Meso-Cenozoic cover in which the same successions of the Ghomaride-Malaguide Units occurred. This realm can also be suggested for the conglomerate levels of the Beni Ider Flysch Fm., taking into account that the Beni Ider Fm. pebbles are lithologically similar to those recognized in the Fnideq Fm. and the debris flows-related features of these conglomerates indicative of a short transport.

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