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SOME CONSIDERATIONS ON PALAEOZOIC SPILITES OF CARNIA
(ITALIAN EASTERN ALPS)

ALCUNE CONSIDERAZIONI SULLE SPILITI PALEOZOICHE DELLA CARNIA
(ALPI ORIENTALI ITALIANE)

Abstract — Petrographic, petrochemical, geochemical and mineralogical features of a spilitic association near Paluzza town (Carnian Alps, Northeastern Italy) are presentend. The data, although not conclusive, point to a transitional versus tholeiitic parent source for the volcanis, linked to rifting processes of a continental crust.

Key words: Spilites, Basalts, Clinopyroxenes, Carnia, Eastern Alps.

Riassunto breve — Vengono presentate considerazioni petrografiche, petrochimiche, geo-
chimiche e mineralogiche sulle associazioni spilitiche affioranti presso Paluzza (Alpi Carni-
che). I dati, peraltro non definitivi, orientano verso un magma genitore transizionale tenden-
zialmente tholeiitico associabile a processi di rifting di crosta continentale.

Parole chiave: Spiliti, Basalti, Clinopirosseni, Carnia, Alpi orientali.

Introduction and geological outlines

In the Carnian mountains (South-eastern Alps) massive spilites, pillow lavas, pillow breccias, hyaloclastites as well as keratophyres and keratophyric tuffs are widespread in the «hercynian Flysch» (GENTILI & PELLIZER, 1964; SPALLETTA et al., 1979). The volcanics are Upper Carboniferous (Namurian-Westfalian) aged and belong to Hochwipfel and Dimon formations (SELLI, 1963). They were genetically attributed to an alkali-olivin basaltic parent magma for «so-called» similarity with Karawanken high TiO₂ spilitics, and were interpreted as connected to transcurrent movements (SPALLETTA et al., 1982).

A «testing zone» was examined near Paluzza town (fig. 1) with the aim to verify
some petrogenetic features of the outcropping volcanics that include all the types described by Gentili & Pellizzer (1964) in a larger area.

In the zone, the Hochwipfel and Dimon formations outcrop in stratigraphic succession, made of turbiditic units (claystones, siltstones and sandstones of the Hercynian Flysch); s. Spalletta et al., 1982 and therein references) and volcanic types belonging to the Dimon formation (following Spalletta et al., 1982), with sequences of massive diabases, weakly porphyritic and hyaloophitic spilites, hyaloclastites and tuffs, «pillows lavas». The series is topped by Medium-Upper Permian sandstones (Val Gardena formation).

Petrography

Over a population of 45 samples, fifteen were selected as representative of the different volcanic rocks distinguished in the field. The main petrographic features of the structurally different outcrops are reported below.

1) Massive diabases (MD. Type: FB9): medium to coarse grained, subophitic texture with plagioclase (Ca-andesine to Na-labradorite) and Ca-rich pyroxenes (subordinately magnetite). Interstitial chlorite, albite, epidote, carbonates and opaques.

2) Weakly porphyritic spilites (WPS. Type: E1, E7, E15, T6, T7): fine grained, weakly porphyritic texture with olivine (chloritized), Ca-rich pyroxenes (sometimes epidotized) and albited plagioclase phenocrysts and magnetite microphenocrysts. Groundmass made of chlorite, opaques and/or altered feldspars (intersertal texture) and epidotized Ca-rich pyroxenes. In some rocks (E1, E7, E15) chloritization processes are dominant, whereas in some types (T6, T7) albition and epidotization are largely widespread.

3) Hyaloophitic spilites (HS. Type: V10, Z4B, Z9): albited plagioclase phenocrysts and opaque microphenocrysts in a glassy (palagonitized and chloritized) to intersertal (partially or almost completely altered into fine-grained aggregates of sericite, epidote and clay minerals) groundmass. Vesicles can be present showing rims of palagonite or chlorite and are filled with carbonates and zeolites.

4) Hyaloclastites and tuffs (HT. Type: T5, Z6, Z4D): largely glassy (with glass sometimes replaced by quartz + chlorite + albite + sericite + epidote aggregates) with flow textures. They contain fragments, variable in size from few mm to some cm (up to «injecta» of Lehman, 1968) with trachytic or intersertal texture.
5) "Pillow-lavas" (PL. Type: Z3, V16, V13): vesicular and intensively altered with interstitial and variolitic textures (albite + chlorite + opaques) and abundant carbonate amygdules.

Petrochemical notes

The chemical nature of the analyzed samples is illustrated from the data of table I and the subsequent diagrams.
It should be emphasized that the large variability of the chemical compositions, linked to "spilitic" alteration, makes obscure the original affinity. As a matter of fact, some high Mg contents in MD, WPS, and Hs types point to chloritization processes, Na enrichment reflects albitionization and so on, as well as the very high Ca and CO₂ values of PL are referable to intensive carbonatation. Moreover the "pillows" present also very high Mn and relatively high ferric iron contents that can be indicative

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**Fig. 3** - Diagram Si, K, Na, Ca, after De La Roche (1974). Symbols as in fig. 2. Points: carbonate free composition of the pillows.

**Fig. 4** - Alkali-silica diagram for more "fresh" samples. Symbols as in fig. 2.

**Fig. 5** - Distribution of spilits (the more fresh samples only) in the classificative diagram of De La Roche et al. (1980).
of laterization processes in subaerial environment (MELFI & CARVALHO, 1983). A petrochemical puzzle is constituted by HT types for the spanning the more variable compositions (up to Keratophyres of GENTILI & PELIZER, 1964) and showing «anomalous» Zr and other incompatible elements concentrations. They can testify an explosive activity which experienced a «sedimentary» (Hercynian Flysch) mixing.

From DE LA ROCHE (1968) and DE LA ROCHE et al. (1974) diagrams (figs. 2 and 3) the samples fit the «spilitics» field with behaviours connected to mineralogical changes and with a generalized trend falling into alkaline suites of Lahn-Dill type (JUETEAU & ROCCI, 1974, DE LA ROCHE et al., 1974). The same behaviour is shown by palaeozoic spilitites of the Karawanken mountains (LOESCHKE, 1973).

But the use of major, minor and trace elements as petrogenetic indicators of altered rocks is seemingly limited to the probable mobility of so called immense elements in the alteration processes. However, considering the more «fresh» samples (as FB9, E1, E7, E15), they belong to transitional and subalkaline fields (figs. 4 and 5), that contrasts with alkaline behaviour of Karawanken volcanics.

Moreover, it is remarkable also the lower TiO₂ content of the Carnian spilites (< 2.7%) versus the higher TiO₂ value (3.5 as average: s. LOESCHKE, 1973) of the Karawanken (fig. 6).

In these cases, the pyroxenes as indicators of the pristine character can have wide relevance (s. VALLANCE, 1973; NESBIT & PEARCE, 1977; DAL NEGRO et al., 1982; LEITERRIER et al., 1982; COMIN-CHIARAMONTO et al., 1983; BELLIERI et al., 1983).

Chemical data for Ca-rich pyroxenes of some analyzed rocks (when containing not altered calcic clinopyroxene crystals) are presented in table II, from which a transitional versus tholeitic trend clearly can be inferred in fig. 7.

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<th>1R</th>
<th>2C</th>
<th>2R</th>
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<td>42.16</td>
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Table II - Representative microprobe analyses of clinopyroxenes of MD (1 to 4: FB9) and WPS (5 to 7: E7; 6: T6) types. C: core; R: rim.

- *Analisi rappresentative dei clinopirosseni di MD (1 a 4: FB9) e WPS (5 a 7: E7; 6: T6). C: nucleo; R: periferia.*
It is noteworthy that TiO$_2$ content of Ca-rich clinopyroxenes reflects the TiO$_2$ contents of the whole rock compositions. This means that clinopyroxenes reflects the primary character of the magmas (Dal Negro et al., 1982).

A notable feature is that the two Ca-rich clinopyroxenes analyzed by Loeschke (1973) have a distinct alkaline character.

At this point the petrologic definition of Carnian spilites by means of geochemical criteria is highly speculative. However, as an attempt, we can use of
discriminant diagrams for plate tectonic environments. The TiO₂ - K₂O - P₂O₅ diagram (PEARCE et al., 1975) appears to indicate a non-oceanic environment (fig. 8), although alteration tends to move oceanic basalts into the non-oceanic field.

The Zr/Y versus Zr and Ti/100 - Zr - Y.3 diagrams (PEARCE & CANN, 1973; PEARCE & NORRY, 1979) indicate «within-plate» basalts (fig. 9), whereas in the TiO₂ - MnO.10 - P₂O₅.10 diagram (MULLEN, 1983) the samples scatter in all the fields, the scatter itself being (following MULLEN, 1983) a significant signature of continental tholeiitic series (fig. 10).

**Concluding remarks**

From the available data on the palaeozoic Carnian spilites some considerations can be made, although not conclusive:

1) The parent magma (s) probably has (have) a transitional versus tholeiitic character.
2) The Carnian spilites do not appear genetically linked to Karawanken spilites which experienced a more alkaline source.
3) The most probable tectonic environment is connected to a continental crust and the volcanism may be linked to rifting processes.

In any case, in our opinion, a more detailed and systematic study must be referred to mineral phases, as Ca-rich clinopyroxenes, in which the pristine character of the original source is preserved. Any approach to petrography, petrochemistry and geochemistry can result significative only for the spilitic alteration processes after the knowledge of a «possible» parent magma.

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RIASSUNTO — Sono state studiate alcune associazioni spilitiche affioranti nelle Alpi Carniche con un’età compresa tra Namuriano e Westfaliano (Carboniferò sup.). I campioni esaminati, provenienti da due zone situate nei pressi di Paluzza, comprendono: diabasi massicci, ialolastoit, spiliti porfirici, tuffiti talora con elementi piroclastici, lave a cuscino.

Lo studio petrografico ha consentito di raggruppare i vari tipi secondo la seguente suddivisione: diabasi massicci, spiliti dolomorfe porfirici, spiliti iolastici, ialolastoit e tuffiti, lave a cuscino.

Lo studio petrochimico, necessario per una caratterizzazione serie delle vulcaniti carniche, è stato eseguito sia su campione di roccia che su pirosseni ricchi di Ca.

I dati ottenuti consentono le seguenti considerazioni, peraltro non conclusive:
1) Il magma originario ha carattere transizione tendenzialmente tholeitico;
2) le spiliti carniche non si possono geneticamente collegare a quelle delle Caravanche;
3) la più probabile situazione tettonica associabile a questo tipo di vulcanesimo è quello di processi di «rifting» in crosta continentale.

References


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