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Alpine "Tonalite" at Miagliano, Biella (Zona Diorito-kinzigitica)

A Preliminary Note

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With 2 figures and 2 tables in the text

Riassunto. Nel presente lavoro viene ripreso l'esame geologico della massa „tonalitica" di Miagliano (Biella) recentemente individuata (Bortolami, Carraro e Sacchi, 1965): la sua dubbia interpretazione quale differenziato del Complesso Basico di Ivrea o piuttosto quale ammasso più recente, compreso nel complesso stesso, e legato al magmatismo tardoercinico o alpino, è già stata sottolineata. Fondati indizi di ordine sia geologico sia petrografico, nel corso di ricerche recenti più dettagliate, hanno indicato come più attendibile la seconda ipotesi.

Le misure di età radiometriche effettuate sulla biotite che compare nei vari tipi litologici costituenti la massa, misure eseguite con il metodo K/Ar e Rb/Sr, hanno dato un'età media di 31 M.A. Data l'assenza di fenomeni retrometamorfici nelle rocce in questione, si può ritenere che l'età ottenuta sul minerale corrisponda alla messa in posto della massa.

Viene confermata in tal modo la natura tardiva della „tonalite" di Miagliano e ne viene inoltre precisata l'età alpina.

Recent work[1]) has demonstrated the presence of tonalite (*l. s.*) rocks in the neighbourhood of Miagliano (Biella), in the Zona Ivrea-Verbano. Further study by one of us (F. C.) has shown such rock to exist on a large scale. It is almost completely masked by alluvial cover, altered to sand in the very few visible outcrops and only found in a fresh state in incisions of the hydrographic network. Aerial photography helped to unravel the extremely complicated geological picture in this area.

Two principal rock masses have been identified; the larger (Miagliano)

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[1]) Bortolami, G., Carraro, F. e Sacchi, R. (1965): Le migmatiti della Zona Diorito-kinzigitica nel Biellese ed il loro inquadramento geotettonico. Nota preliminare. Boll. Soc. Geol. It., *84* (2), 5—21, 7 tt.

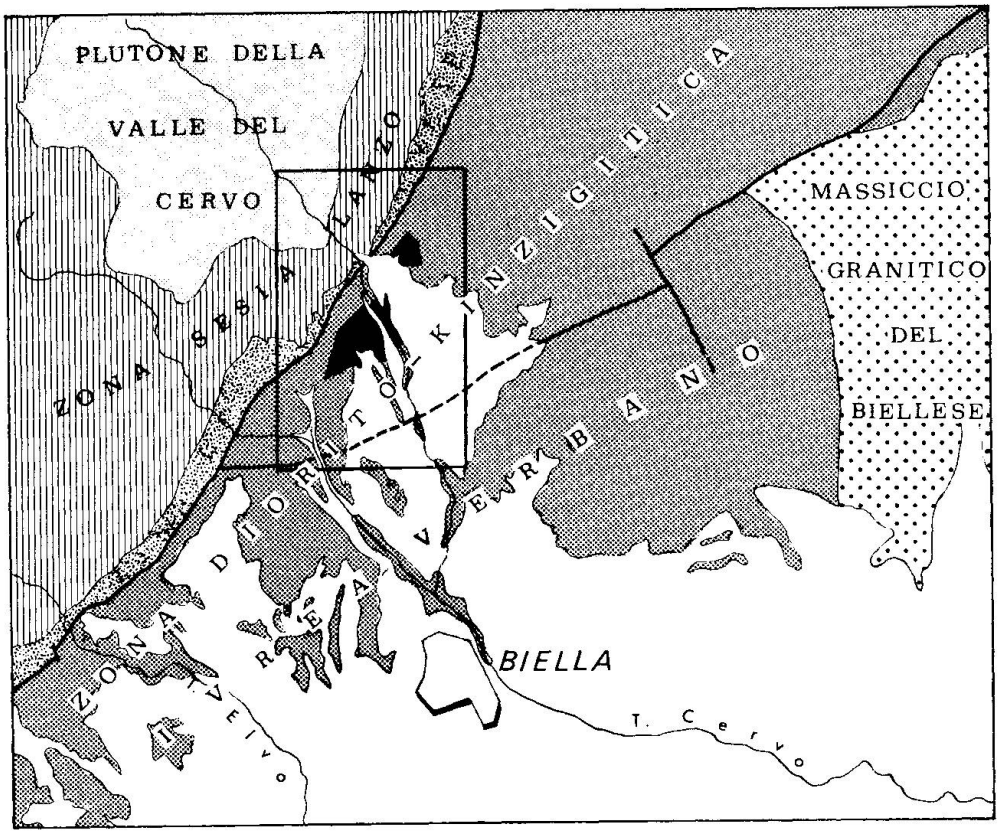

Fig. 1. Tectonic map of the region around Biella, showing the location of the Alpine "tonalite".

mass runs transversally to the Cervo Valley north of Miagliano; the smaller lies about 1 km north of the first.

Three rock types arranged in a concentric fashion make up the Miagliano mass: core of monzonite with amphibole phenocrysts, an intermediate sector of medium-grained diorite and an outer zone of microdiorite; some monzodiorite is associated with the central monzonite. Transitions from one formation to the next are generally sharply defined and the reciprocal relationships

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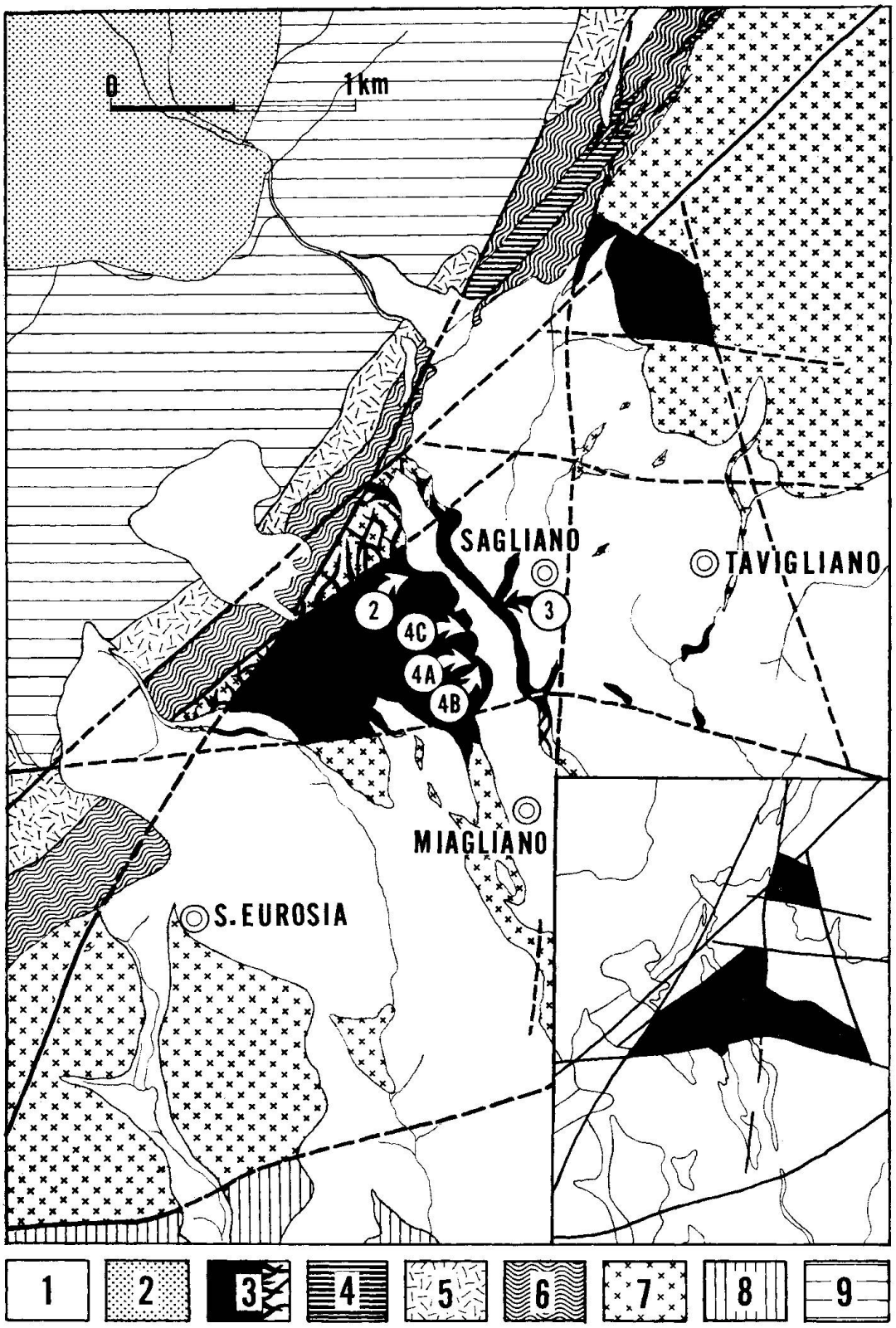
Fig. 2. Geological map of the Miagliano area. The insert shows the probable extension of the two masses below the quaternary cover.

1. Alluvium and landslide deposits (Quaternary). 2. Plutone della Valle del Cervo: granite, syenite and monzonite (Tertiary). 3. "Tonalite" and connected rocks and dikes (Tertiary). 4. Microdioritic dike (Tertiary?). 5. Volcanics of the Serie del Canavese (Permo-Carboniferous). 6. Fine-grained, variously mylonitised, chlorite-epidote- and chlorite-sericite-epidote-gneisses and serpentinites (pre-Upper-Carboniferous). 7. Zona Ivrea-Verbano: gabbros, biotite-sillimanite-gneisses and acidic granulites (pre-Upper-Carboniferous). 8. Migmatites connected with the Graniti dei Laghi (late-Hercynian). 9. Zona Sesia-Lanzo: "micascisti eclogitici" (garnetiferous, Na-pyroxene- and amphibole-bearing micaschists: pre-Upper-Carboniferous).


0
1km
SAGLIANO
TAVIGLIANO
MIAGLIANO
S. EUROSIA
2
3
4C
4A
4B
1
2
3
4
5
6
7
8
9

between them suggest the following chronological succession: 1. peripheral microdiorite; 2. medium-grained diorite (intermediate sector); 3. fine-grained monzodiorite (nucleus); 4. monzonite with amphibole phenocrysts. There is a tendency to a decussate texture in all these facies. In contrast with the surrounding Ivrea-Verbano gabbro, the mass shows no signs of retrogressive metamorphism, and the widespread cataclasis and mylonitisation of the surrounding rocks is almost entirely absent.

In its northern sector, the relative symmetry of the mass is interrupted by an ENE-WSW belt of hornblendite with pegmatitoid biotite. This is accompanied by smaller bands and roughly corresponds with the boundary between the medium-grained diorite and the monzonite with amphibole phenocrysts. The hornblendite is also lacking in signs of diaphthoresis and the smaller bands are often fragmented; various stages of assimilation on the part of the surrounding rocks can be observed. In general, the boundaries between the hornblendite facies and the main mass are clear-cut, though fringed.

The mass can also be clearly distinguished from the surrounding diaphthoretic gabbro; in the latter, a thick network of veins and dikes of granite and aplite, of varying extent, forms an aureole around the mass. Fine-grained chlorite-epidote schists, a product of advanced Pre-Alpine diaphthoresis of the gabbros, are locally found at the edge of the eruptive body, and here the dikes are absent.

The composition of the smaller mass is varied and apparently without any particular order; rock-types include microdiorite, monzonite and muscovite-microgranite. Whereas the larger mass is surrounded solely by gabbros, here kinzigite-gneisses and acidic granulites are also found.

The fine-grained chlorite-epidote gneisses and the variously mylonitised serpentinites which flank the Canavese Line (Insubric Line) are intruded by a prominent microdioritic dike, about 100 metres wide. This runs for about 1.5 km and, unlike the two principal masses, displays widespread deuteric-type alteration and well-marked evidence of cataclasis.

At present, only the Miagliano mass has been studied in some detail. In our first report (CARRARO and others) it was suggested that two interpretations were possible: an acidic differentiation of the gabbroic mass, or the product of later (late Hercynian or Alpine) magmatism.

Subsequently, however, we were able to distinguish the upper chronological limit of both the progressive and the retrograde metamorphic processes. In 1966[2]), one of us reported the finding of a non-metamorphic carboniferous conglomerate in the cover series showing pebbles of Ivrea-Verbano and Sesia-Lanzo rocks, both groups of which are often diaphthoritic. Since, unlike its

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[2]) CARRARO, F. (1966): Scoperta di una serie carbonifera di copertura degli gneiss-Sesia. Boll. Soc. Geol. It., *85*, 241—252, 2ff.

surrounding gabbros, the Miagliano mass completely lacks signs of metamorphic processes, the second interpretation was in this way indirectly confirmed; i. e. the Miagliano mass must be linked to a more recent magmatic cycle than the surrounding gabbro.

Radiometric age determinations were therefore carried out (G. F.). The Rb/Sr and K/Ar methods were employed in determining the age of specimens of biotite obtained from the different facies of the eruptive body. The standard isotope dilution techniques long in application at the Nuclear Geology Laboratory, Pisa, were employed. In applying the Rb/Sr method of age-determination, we used the decay constant $\lambda = 1.47 \times 10^{-11} yr^{-1}$. The initial Sr isotope composition was in the ratio of $^{87}Sr/^{86}Sr = 0.707$; this value was obtained by

Table 1. Rb/Sr measurements

2. hornblendite from the larger belt; 3. biotite-hornblendite (larger belt); 4A. monzonite with amphibole phenocrysts (nucleus); 4B. fine-grained leucocratic monzodiorite (nucleus); 4C. fine-grained melanocratic monzodiorite (nucleus)

sample number and mineral	Rb (ppm)	comm. Sr (ppm)	rad ^{87}Sr (ppm)	$\frac{\text{rad } ^{87}Sr}{\text{tot } ^{87}Sr}$	$\frac{^{87}Sr}{^{86}Sr}$	$\frac{^{87}Rb}{^{86}Rb}$	age (m. y.)
2 biotite	404	7.4	0.0506	0.09			30
3 biotite	367	18.4	0.0502	0.037			33
4A biotite	496	5	0.0646	0.16			31
4C biotite	611	9.4	0.0809	0.11			32
3 whole rock	57	295			0.7075	0.56	
4A whole rock	86	556			0.7070	0.45	

$^{87}Rb = 1.47 \times 10^{-11} yr^{-1}$; initial $^{87}Sr/^{86}Sr = 0.7070$

Table 2. K/Ar measurements (samples as in Table 1)

sample number and mineral	K (%)	rad ^{40}Ar cc STP. 10^{-4}/grK	rad ^{40}Ar (%)	age (m. y.)
2 biotite	2.80[3])	1.14	40	29
3 biotite	6.20	1.30	75	32
4 C biotite	7.02	1.27	57	32
4 B biotite	7.16	1.36	57	33

$^{40}K : \lambda = 5.3 \times 10^{-10} yr^{-1}$; $\lambda\beta = 5.85 \times 10^{-10} yr^{-1}$

[3]) The biotite concentrate used for sample 2 contained an appreciable amount of amphibole, which accounts for the low K content.

direct measurement of the isotope composition of 2 whole rock specimens (3 and 4A). Deviations were ± 2 m.y. and ± 1 m.y. with the Rb/Sr and the K/Ar methods respectively.

There is a marked degree of agreement between the two sets of results, and the mean age of biotite in the Miagliano mass can be assumed to be 31 m.y. The absence of indications of retrometamorphism in the different facies means that this age corresponds to that of the emplacement of the mass.

Samples from the smaller mass are being subjected to dating tests; particular attention is being paid to the muscovite-microgranite facies, since this is not found in the larger mass.

The shape of both masses seems to be clearly linked to the tectonic arrangement of this sector of the Zona Diorito-kinzigitica. The contrast between the intensely cataclastic surrounding gabbro and the lack of deformation in the two masses points to post-kinematic emplacement of the recent igneous rocks during a stage of dilatation. The two Alpine eruptive bodies are both limited by faults; these faults must have been present before their emplacement since the igneous rocks are never affected, even in zones of immediate contact; in fact, in some places (southern sector), they apparently interrupt the continuity of the faults.

Insufficient data are available for determining the nature of the emplacement mechanism; either soaking of much-fractured lumps of the gabbroic mass by introduced granitic material during a phase of release of compression, or intrusion may be suggested. The first of these views seems to be supported by the petrographic variety and the hybrid character of the masses, as well as the arrangement of the rocks.

We shall conclude by stressing the fact that much of the field data indicate that Alpine magmatic phenomena were somewhat widespread throughout the south-western sector of the Zona Diorito-kinzigitica; they are nearly always connected with pre-existing faults. This in turn raises the question as to the nature of the criteria to be adopted in distinguishing these Alpine rocks from the numerous, and sometimes very similar, late-Hercynian products.