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The Southern Alps: an aborted Middle Triassic mountain chain?[1])

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In current palaeotectonic synthesis, the Southern Alps are interpreted as a zone of Middle Triassic precursory and "aborted" rifting (BECHSTÄDT et al. 1978) predating the Jurassic opening of the Tethys ocean by some 20 million years, and only recently the alternative hypothesis of an aborted Middle Triassic mountain chain has been presented (PISA et al. 1980; CASTELLARIN et al. 1980). In this note we review the implications of this hypothesis for the crustal and sedimentary evolution.

In fact, in the Triassic of the Southern Alps no alkaline magmatism exists and volcanics show clear calc-alkaline and/or shoshonitic affinities. Similar data were obtained recently on the Middle Triassic effusive rocks of the Dinarides (BÉBIEN et al. 1978) and according to geochemical criteria reviewed by BÉBIEN (1980), the Triassic magmatism of the Southern Alps displays an orogenic character (Fig. 1). Products of Triassic tectonism comprise 1. unconformities in the topmost Ladinian/lower Carnian sequence; 2. folds, faults and thrusts with tectonic repetitions of Permian, Scythian-Anisian and Ladinian successions (PISA et al. 1980, Fig. 2); 3. chaotic formations, considered so far as products of explosive volcanism (LEONARDI 1968) or, alternatively, as gravity slide structures produced by Middle Triassic tensional tectonics (CASTELLARIN et al. 1977). However, new observations show that these structures lay along major compressional belts. Presently we think that part of the chaotic formations may have originated from extensive gravitational sliding from submarine structural highs - scarps and ridges - produced by Middle Triassic compressional folding and thrusting. Part of these formations were again involved in deformation along and below thrust fronts, resulting eventually in melange-like chaotic associations.

Because calc-alkaline magmatic activity is at odds with current concepts of rifting, we try to interpret the observed data by a subduction mechanism. French authors (BÉBIEN et al. 1978; CELET et al. 1977) pioneered the interpretation of the Middle Triassic volcanism of the Dinarides by a classical subduction model. In the Dolomites area, however, the following boundary conditions have to be taken into

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account: 1. No oceanic crust was present during the Middle Triassic in an area adjacent to the Southern Alps (including the Northwest Dinarides and the Apennines). 2. No certain Middle Triassic orogenic metamorphic phase is known in the Alps or Apennines. 3. No true Triassic mountain chain was formed in the Southern Alps, however, a sharply defined, elongated, mostly volcanic high was located along their southern border and below the adjacent Po Plain. 4. The compressional structures are decollements and document only limited shortening of the Permian to Middle Triassic cover without the basement involved. 5. The compressional tectonic elements apparently are of limited lateral extent towards the west and were not found in the adjacent areas of the western Trentino and in Lombardy.

A *modified* subduction hypothesis seems thus necessary in order to explain the volcanism and to respect at the same time the mentioned boundary conditions. We are, however, aware that this solution will appear as a sort of *deus ex machina* and as heretical with respect to classical models. We propose a scheme based on the absence of continental margins and of related collisional phenomena (see Fig. 2 in CASTELLARIN et al. 1980). The detachment of sinking lithosphere underneath the crust does not necessarily lead to strong compression in the overlying levels in which shortening may be restricted to decollements in the cover. In fact, the lateral discontinuity of the tectonic elements seems to be in line with decollement structures.

For our interpretation, a most important problem is to locate the oceanic area closest to the Southern Alps during the Middle Triassic. This may have been the so-called Palaeotethys ocean, a wedge-shaped large embayment separating the Eurasian and Gondwanian continental blocks, which disappeared by subduction of

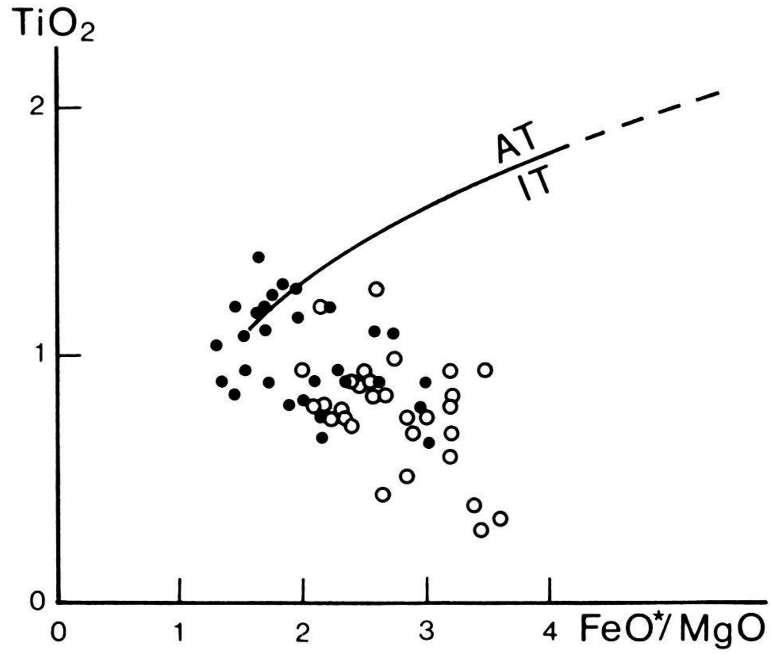

Fig. 1. TiO_2-content versus FeO*/MgO ratio in Middle Triassic volcanic (full circles) and basic intrusive rocks (open circles) of the Dolomites, Southern Alps. IT = isotitaniferous "orogenic"; AT = anisotitaniferous "anorogenic" association fields (BÉBIEN 1980). Note the negative correlation mainly in the intrusive sample distribution: i.e. a trend typical for the calc-alkaline series.

oceanic crust along or close to the "Cimmerian-Indosinian Suture" (HSÜ & BERNOULLI 1978). In our assumption this process would have been active during the Middle Triassic, however, subduction of oceanic crust cannot be assumed to have taken place as far to the west as the Dinarides and particularly the Southern Alps. However, as these areas were located on the direct WNW prolongation of the oceanic Palaeotethys and its subduction zone, we may expect that also the ensialic area to the west was involved and that the upper mantle below the sialic basement of Dinarides and Southern Alps was forced to sink.

The consumption of oceanic crust in the Palaeotethys may have been balanced by crustal extension in southerly areas. A possible area could be located in the eastern Mediterranean where allochthonous ophiolites of presumably Middle Triassic age (JUTEAU et al. 1974) occur in the Antalya-Cyprus-Hatay belt. The western prolongation of this belt could be present in the Triassic basins of the external Hellenides, the Dinarides and the Southern Alps, lying to the south of the compressional zone of the Dolomites and the internal Dinarides. Possible equivalents in the Apennines could be the Triassic basins of Lagonegro, Sicily and

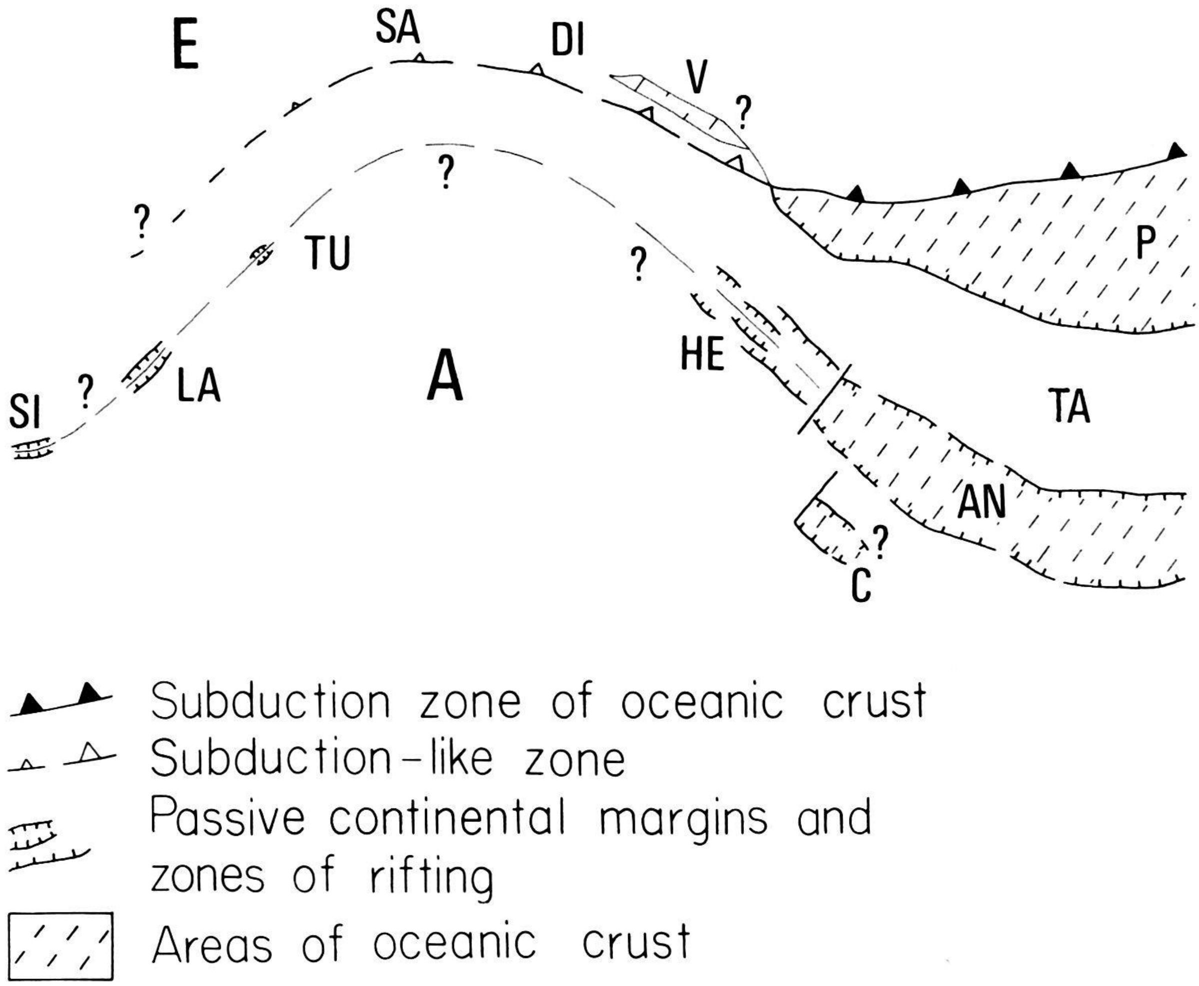

Fig. 2. Very hypothetical and simplified palinspastic map for the Middle Triassic in the central Mediterranean area, mostly based on trends of volcanism. A = African block; B = European block; SI = Sicily; LA = Lagonegro; TU = Tuscany (Punta Bianca); SA = Southern Alps; DI = Dinarides; V = Vardar; HE = Hellenides; C = Cyprus; AN = Antalya; TA = Taurides; P = Palaeotethys.

Tuscany. Whereas in the latter area an alkaline trend was recently recognized in the associated mafic effusive rocks (RICCI & SERRI 1976), the volcanics of the remaining basins are completely unknown in geochemical and petrological respects. Our interpretation should therefore be regarded as a simple palaeogeographic working hypothesis based on possible geometrical relationships (Fig. 2).

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