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## Recent Studies on Pb-Zn-Fluorite and Barite Deposits in the Mid- and Upper-Triassic Series of the Lombardic Prealps (Northern Italy)<sup>1)</sup>

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With 4 figures

Schlüsselwörter

*Pb-Zn-Fluorite*  
*Pb-Zn-Barite*  
*Trias*  
*Lobardische Voralpen*  
*Luganer Platte*  
*Paläogeographie*  
*Plattentektonik*  
*Metallogenese*

### Introduction

Over the last few years, ore exploration and metallogenic studies on the lead - zinc - fluorite - barite deposits linked to the Triassic carbonate rocks in the Eastern Italian Alps *s. l.* have led to interesting results. This paper summarizes the results of the recent studies, published or otherwise; above all, it is a synthesis of the data obtained by studies currently carried out on the numerous deposits present in the Lombardy region.

All the mineralizations, like the well-known Raibl, Bleiberg-Kreuth and Mežica deposits, belong to the "strata- and time-bound alpine ores" (*sensu* MAUCHER & SCHNEIDER, 1967).

Two great structural features are defined within the Permo-Triassic domain of the central Southern Alps (BOSELLINI, 1965):

- the Lukanese platform, characterized by condensed, reduced sedimentation;
- the Lombardic basin, with a great thickness of sedimentary sequences.

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The different distribution of the metallogenic cycles, mainly related to the Mid-Upper Triassic, agrees with this paleogeographic pattern (Fig. 1).

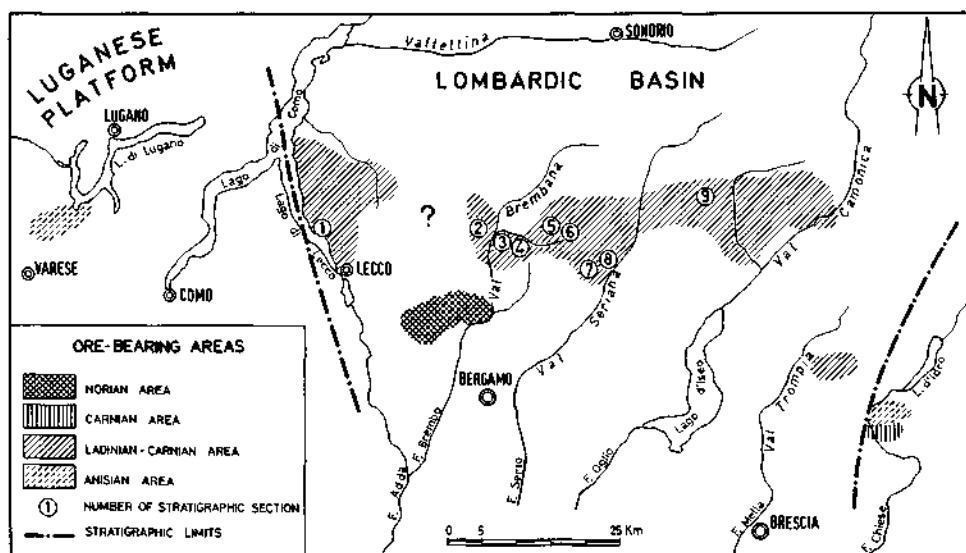


Fig. 1

## 1. Luganese Platform

In the Luganese platform the Triassic lies essentially on the Permian volcanites (Lugano porphyries). The metallogenic cycle is of Anisian age. Lead and zinc occurrences are known in Besano, Bisuschio and the Valganna areas, north of Varese. Geochemical prospecting has shown outcrops of the same mineralization beyond the Swiss border. The galena-, sphalerite- and barite-bearing ores show stratiform-synsedimentary features, and appear to be restricted to a thin level, from a few decimeters to several meters in thickness, rich in organic matter (bitumen, used in places for the production of ichthyol). This level pertains to the so-called "Grenzbitumenzone" located at the Anisian-Ladinian boundary (S. Salvatore Dolomite - Meride Limestone). It represents a phase of shallow-water sedimentation in euxinic marine channels inside the carbonate platforms.

## 2. Lombardic Basin

In the Lombardic basin, the Triassic metallogeny is related to the Ladinian-Carnian boundary and, though to a much lesser extent, to the Norian. The Triassic series consist (ASSERETO & CASATI, 1965) of a thick sequence of alternating carbonate platform- and terrigenous sediments, overlying the volcanoclastics of the Collio-Verrucano Lombardo Formations (Permian).

### 2.1. Mineralization at the Ladinian-Carnian boundary

The Ladinian-Carnian ore-bearing sequences are often named "Metallifero". Their stratigraphic parameters and lateral variations are shown in Fig. 2.



Litho-sedimentologically, all these mineralized sequences (which developed between the top of the Ladinian carbonate platform – Esino Limestone – and the Carnian deltaic-lagoonal Val Sabbia Sandstone and Gorno Formation) are characterized by variable thickness and include, from bottom to top, a peritidal carbonate platform facies (with sub-intertidal to supratidal cyclic sedimentation) grading to a basinal facies of restricted circulation. From the chronostratigraphical point of view, the typical “Metallifero” column includes various formations (Esino Limestone, Breno Formation, Metallifero Bergamasco Limestone, lower tongue of the Gorno Formation). Part of the stratigraphic sections of Fig. 2 represent allochthonous sequences (Lecco, Arera, Val Parina and Riso, Trevasco, probably Presolana) connected with the gravity tectonics of the Southern Alps.

### 2.1.1. – Lecco Area (Fig. 4)

Only preliminary data are available for this area.

The “Metallifero” has an average thickness of 130–150 meters. The lower part is characterized by a predominantly supratidal facies (micrites and dolomicrites closely alternated and syndiagenetically deformed). The middle-upper part (about 120 meters thick) consists of well-stratified, yellowish dolomicrites, with thin chert intercalations.

The most important mineralization (large irregular breccia bodies with galena, sphalerite, barite and traces of fluorite) is localized between the lower and middle-upper part of the “Metallifero”. A very low-grade mineralization (spots, nodules and small veins of prevailing galena) is to be found in the middle to upper stratified part of the “Metallifero”.

### 2.1.2. – Gorno Area

In this area, two zones with differing characteristics of paleogeography and ore mineral assemblage are distinguishable (Fig. 3):

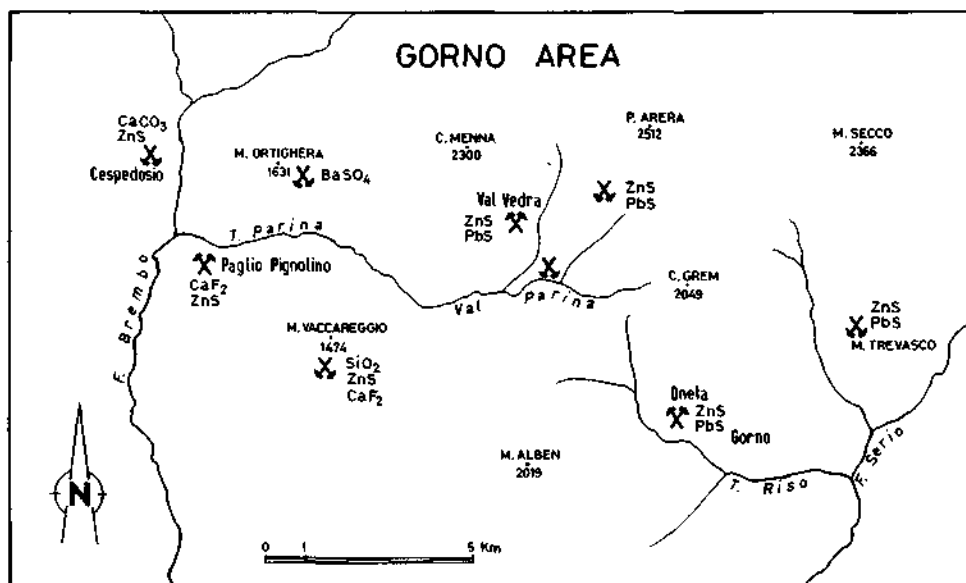


Fig. 3

a) western zone (middle-high Brembana Valley, with Paglio Pignolino, Vaccareggio and Pedrozio deposits and Ortighera, Valbona, Cespedosio-Saetta occurrences).

Overlying the upper levels of the Calcare Rosso unit (bedded polychrome clays) the "Metallifero" (average thickness of 100–160 m) displays a lower tidal flat facies (Breno Formation + Metallifero Bergamasco Limestone: light grey to dark limestones) and an upper back-platform facies (lower tongue of the Gorno Formation: black shales) grading to fine-grained volcanoclastics of the Val Sabbia Sandstone. Connected with contemporaneous volcanic activity, localized emersions took place at the top of the Metallifero Bergamasco Limestone (Paglio Pignolino, Vaccareggio, Pedrozio areas) with erosion and karstification of the underlying limestone sequence, before the transgression of the black shale. In this environment, two types of mineralization, genetically linked to the black shale facies, are recognizable:

a) in the black shales themselves, syndiagenetically mineralized at the base with stratiform ore;

b) in the karst cavities polyphasic ore networks, either with prevailing bedding-parallel features (Paglio Pignolino) or with discordant structures (Vaccareggio) geometrically related to the emersion surfaces (JADOUL & OMENETTO, 1975; ASSERETO, JADOUL & OMENETTO, 1977).

The several ore deposits show a clear paragenetic zoning: prevailing fluorite at Paglio Pignolino, quartz (with sphalerite and galena) at Vaccareggio, Pedrozio and Cespedosio, barite at Ortighera;

b) central - eastern zone (Val Vedra, Val Parina, Area mines and Riso-Trevasco mines). In this zone the "Metallifero" is mainly defined by tidal flat facies, paleogeographically transitional from the back-platform Carnian facies (Val Sabbia Sandstone and Gorno Formation) to the carbonate platform facies (Esino Limestone), quickly migrating northwards in time. This transitional unit, with a constant thickness of 50 to 75 m, shows welldefined boundaries with the lower and upper formations, marked by thin argillitic layers, called Tuffite 1 and 2. The lower part of the "Metallifero", overlying the Esino Limestone and, locally, also the Calcare Rosso, is characterized by peritidal carbonate platform facies, with subintertidal to supratidal cyclic sedimentation. The upper part of the "Metallifero" shows clear facies changes, connected with climatic variations and increasing terrigenous supply under euxinic environmental conditions (black limestones and black shales *l. s.*). A stable backplatform with deltaic volcanoclastic and/or lagoonal sedimentation (Val Sabbia Sandstone and Gorno Formation) overlies the "Metallifero".

The sphalerite-galena ores are mainly linked to the black shale facies and are typical stratiform syndiagenetic deposits of notable extent. Another type of economic mineralization exists, with various physiographic characters (pseudoconcordant or discordant columnar bodies developed within "enrichment volumes" defined by the Triassic syngenetic tectonics). As an example, we mention the Val Vedra deposits, where stratiform and discordant bodies, in the upper "Metallifero", are linked spatially to tectonically moulded carbonatic "paleohighs", subject to emersion and erosion with related karstification, essentially conditioned by lithology, bedding and the presence of impermeable horizons (tuffites and Calcare Rosso) (OMENETTO & VAILATI, 1977). These particular mineralizations seem to be derived from a primary "seeping down", inside the karst cavities, of the overlying black shales, unconformably transgressive and particularly ore-enriched above the eroded paleohighs.

In the central-eastern Gorno area, autochthonous (Val Vedra) and allochthonous (Parina, Arera) mineralized sequences are present. The latter are in connection with more extensive overthrusts, from north to south, common in the Lombardic basin area.

### 2.1.3. - Presolana Area (Fig. 4)

In this area, situated on the eastern border of the Lombardic basin, are the Presolana fluorite deposit, the Pagherola barite deposit and other minor occurrences.

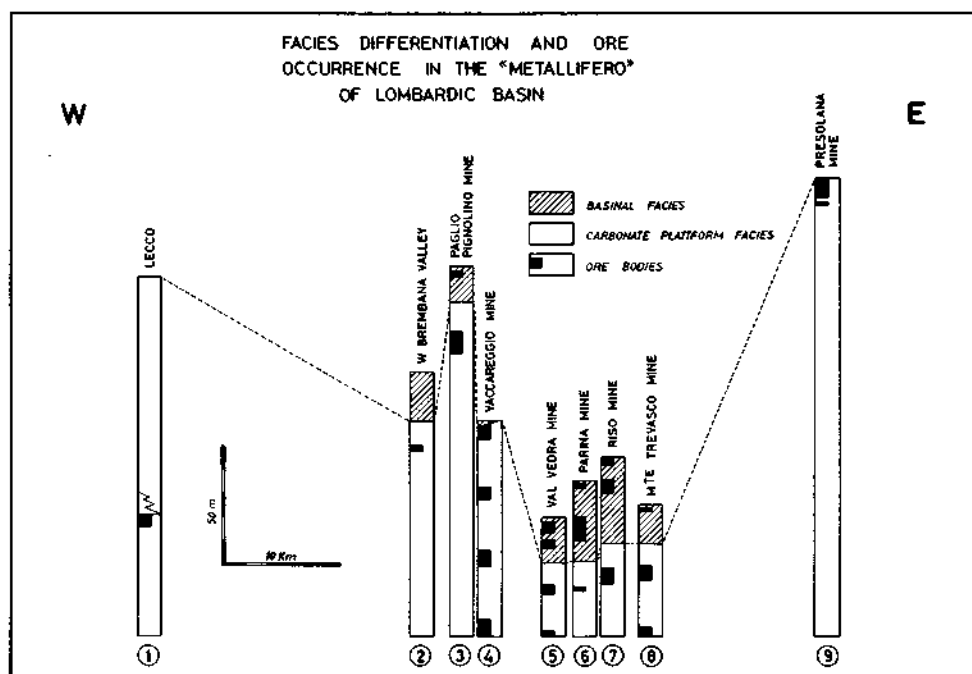


Fig. 4

As regards the marginal western part (Lecco area), the "Metallifero" is represented in this area too by a thick (190 m) carbonate platform sequence (Breno Formation). The limestones prevail, with typical cyclic emersion fabrics. The migration of the carbonate platform towards the north-east continued here until the middle Carnian.

The fluorite mineralization (with minor lead-zinc sulfides) is located on the top of the carbonate paleorelief, overlain by transgressive back-platform clays and marls (Gorno Formation). The orebodies show parallel columnar shapes, with a north-south direction, probably conditioned by the structural pattern of the paleorelief. The ores are characterized by typical resedimentary and mobilization fabrics. As regards many other deposits linked to paleoreliefs, a particular association exists, with peculiar, dark-grey quartz "crusts", frequently scattered as small outcrops over the surface of the carbonate paleorelief (RODEGHIERO, 1977).

Barite deposits, with subordinated fluorite and sulfides, are observable in a stratigraphic level a few meters lower (small N-S-trending "columns").

Overlapping the parallel distribution of the orebodies from west to east, a paragenetic zoning is recognizable (barite prevailing in the western part, fluorite in the central, and lead-zinc sulfides in the eastern part of the area).

From a structural point of view, the primary geostratigraphic framework is complicated by numerous overthrusts of alpine age. "Allochthonous" units ("wedges") are superim-

posed on an "autochthonous" monocline, so that there is often a repetition of the whole stratigraphic ore-bearing sequences.

## 2.2. Mineralization in the Norian

Fluorite occurrences have recently been discovered in the southern part of the Lombardic basin (to the west of the Brembana Valley, Fig. 1). The mineralization is connected either with the upper Norian lithofacies (Dolomia Principale) at the Camissinone (ISOLI, 1972), or with the Infra-Rhaetian lithofacies (Zorzino Limestone) at the upper boundary with the Dolomia Principale, at Monte Albenza (MARTINA, 1966).

The mineralization (mainly quartz and fluorite) forms essentially discordant lenses, strictly connected with fractures (paleofractures?). Noteworthy are the presence of abundant quartz at the base of the orebodies and the position of the orebodies at the top of the dolomitic platform, subsequently drowned by transgressive argillitic-limestone units.

## 3. Val Sabbia Area

At the eastern margin of the Lombardic basin, a peculiar group of small deposits (at present under investigation) is known in the restricted Val Sabbia area (east of the Camonica Valley, Fig. 1). In this area, the Triassic series overlies the Permian sequences (from bottom to top: Collio Formation, Verrucano Lombardo and Val Gardena Sandstones).

Different types of mineralization are present in various stratigraphic horizons of the Triassic series (from Anisian to lower Carnian). In the upper-Anisian nodular grey limestones with argillitic intercalations are to be found mineralized with galena, sphalerite and minor fluorite and barite. The orebodies are discordant with irregular shape and typical brecciated structures (Casina della Vena, Dosso dei Pini). Occurrences of barite and subordinate galena (Barghe) are to be observed at the boundary between the upper Ladinian (Esino Limestone) and the tuffaceous conglomerates of the lower Carnian. Other sphalerite and galena ores, very similar as regards stratigraphic position and paragenesis to those of the "Metallifero", are linked to the upper part of the Esino Limestone (Piombatico and Valle dei Ronchi). Furthermore, in the Carnian limestones and volcanoclastics, copper-bearing mineralization exists, linked to porphyritic dykes.

The above-mentioned mineralization shows affinities with those present in the Schio-Recoaro zone. These affinities should underline the transitional character of the Val Sabbia area to the Atesine platform or, alternatively, its pertaining to this paleogeographic domain.

## Concluding Remarks

From this brief summary of the characteristics of Triassic mineralizations in the Lombardy region, it would appear that there is a noticeable difference in the metallogenic events in connection with the different paleogeographic evolution of the major structural elements (platforms and basins respectively).

In the Luganese platform, the lead-zinc metallogenesis is, in fact, expressed solely at the Anisian-Ladinian boundary.

In the Lombardic basin, the exploding metallogenic cycle appears to be chronostratigraphically linked to the Ladinian-Carnian boundary, and, as far as is known up to now, only in a minor part to the upper levels (Norian to Rhaetian). The Lombardic basin can be divided into three main domains, with symmetrical distribution (Fig. 2):

- a central part, corresponding to the Gorno area, characterized by a relatively constant

thickness of the "Metallifero" and by linking the principal mineralization and the shale and/or black limestone basinal facies;

– two marginal parts (Presolana and Lecco areas), characterized by the increased thickness of the "Metallifero", the notable reduction (and local disappearance) of the bituminous facies and the location of the mineralized levels in the lower "Metallifero" (Breno Formation).

Finally, at the easternmost border of the Lombardic basin (Val Sabbia: a transitional area to the Atesine platform, or alternatively part of the same platform), the metallogenic events developed over a wider stratigraphical spectrum, involving several stages of the middle and upper Triassic. This variability of the stratigraphical and ore deposition parameters appears to suggest a particular paleogeographical and paleotectonic instability, characterizing the transitional zones between the major structural units.

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