The Age of Mineral Deposits in the Permian Volcanites of Trentino-Alto Adige (Northern Italy)

Francesco Bakos, Aldo Brondi, and *Giuliano Perna*

Introduction

The Permian volcanites which constitute the porphyric platform of the Adige Valley*, about 4000 km² wide, are cut by several hydrothermal veins**. These mineralizations are known from a minerogenetic and typologic standpoint through numerous and important studies carried out by several authors***. Only for some of these deposits the age has been ascertained. Chronologic attribution for many others is still lacking.

The better knowledge finally acquired on the stratigraphy of the central part of the volcanic platform, where the most important mineral concentrations occur, allowed to obtain new data on the spatial and chronological relationship between volcanites and the included mineral deposits.

Stratigraphy

The Permian volcanites of Trentino-Alto Adige overlie directly the metamorphic basement. Only locally a thin conglomeratic layer, made up mostly of metamorphic debris, separates the above mentioned formations. In the northern part the volcanites come in contact with the Ivigna Paleozoic granite. In the southern part on the contrary a similar direct contact with the contemporaneous Cima d'Asta granite is lacking.

The volcanites may be subdivided in three main groups: a lower group (about 1000 m thick), very heterogeneous and mostly constituted by latite--andesitic and latitic lavas and tuffs, by rhyodacitic ignimbrites and lavas and by conglomerates, volcanic sandstones and siltstones (TQ in Fig. 1); a middle group, with an average thickness ranging from 500 to 900 m of wery large and homogeneous layers of rhyodacitic ignimbrites and of local and irregular intercalations of volcanic sandstones and siltstones (Q_4—Q_1 in Fig. 1); an upper group, more than 1000 m thick, made of very

* The series of Permian volcanites of this region is widely illustrated in the legend of Fig. 1, to which M. Nardin contributed.

** It exists also, as it will appear later, a sedimentary mineral deposit in the "Scisti di Tregiovo" (Tregiovo Shales).

*** See in bibliography the most important works.

Explanation of Figure 1

8—9	Fifth group of mineral deposits (type 2)
7	Ladinian dikes
Bell.	Bellerophon Formation
AvG	**Val Gardena sandstones** with local conglomeratic levels containing porphyry debris at their base
R_1	**Rhyolitic ignimbrites** brick-red in colour and with local vitrophyres at their base (V)
T_2	**Rhyolitic tuffaceous ignimbrites** greenish-grey in colour, sometimes very compact in the basal or central portion and with sporadic ignimbritic debris of the R_2 facies. Local intensive reworking traces at the top of the levels, sometimes with sandy or clayey beds
M	**Tregiovo shales,** formation made of shales, partially calcareous, with frequent lacustrine carbonaceous facies mostly at the base of T_2. They occur sometimes at the top of T_3 and T_4 or constitute local interbedding among the basal layers of some rhyolitic layers
6	Fourth group of mineral deposits (type 1)
R_2	**Rhyolitic ignimbrites** violet-red in colour with euhedral phenocrystals. They are mostly whitened because of hydrothermal-pneumatolitic autometamorphism. Subvolcanic facies are frequent. Vitrophyric facies at their base (V)
T_3	**Tuffaceous rhyolitic ignimbrites.** Mostly ignimbritic at their base with fragmental or spheroidic bodies of the same nature as the matrix. They are tuffaceous in the middle parts, and sandy-conglomeratic with intensive reworking and with lacustrine beds in the upper parts
R_3D	**Rhyolitic domes** with great pink feldspars with resorption borders. They are genetically correlated with the rhyolitic complex R_3
R_3L	**Rhyolitic lavas** R_3
R_3	Rhyolitic ignimbrites violet-pink in colour, highly whitened because of hydrothermal-pneumatolitic autometamorphism. Vitrophyric facies at their base (V)
T_4	**Volcanic breccias,** and **conglomerates, sandstones** and **siltstones** derived from erosion and reworking of underlying Q_3, Q_2, and chiefly Q_1 ignimbrites. At the basal part of the complex tuffaceous-conglomeratic levels frequently occur
5	Erosion
4	Third group of mineral deposits (type 1)
3	Volcano-tectonic rocks
Q_1	**Quartzlatitic** and **rhyodacitic ignimbrites** dark-grey in colour with violescent or reddish shading
T_5	**Conglomeratic tuffs** with both lava and tuff inclusions derived from the basal complex *TQ*. This level represents a contemporaneous phase of the basal volcanic system with the effusions of the Q_3—Q_1 complex
Q_2	**Quartzlatitic ignimbrites** violescent-red and brick-red in colour with a high content of biotite
T_6	**Rhyodacitic conglomeratic tuffs** with local conglomeratic ignimbritic facies; the conglomeratic elements, often presenting remarkable sizes, are frequently of the same nature as the matrix. Phyllitic clastics are rare
Q_3D	**Rhyodacitic domes** with great pink feldspars, contained or genetically correlated to rhyodacitic complex Q_3
Q_3	**Rhyodacitic ignimbrites** green or greyish green in colour; they are locally red because of superficial weathering or whitened because of hydrothermal-pneumatolitic weathering
T_7	**Quartzlatitic conglomeratic** and **sandy tuffs** red in colour and partially reworked; they are genetically correlated with the ignimbritic complex Q_4
Q_4	**Rhyodacitic** and **quartzlatitic ignimbrites** dark red in colour with a high content of biotite
2	First and second group of mineral deposits (type 1)
TQ	**Trachiandesites** and **quartzlatites** of the basal volcanic complex
CB	**Phyllitic transgressive conglomerate** sometimes at the base of the volcanic platform and locally (Mt. Rasciesa) interbedded between two quartzlatite ignimbritic layers
G	**Hercynian granites**
1	First group of mineral deposits
BC	**Metamorphic basement**
1	Vignola, Valar veins
2	Nogarè veins
3	Volcano-tectonic faults
4	Terlano veins
5	Erosion surface
6	Montagiù veins
7	Ladinian porphyritic dikes
8	S. Elena veins
9	Campegno, Vallarsa, Pozzi and Prestavel veins

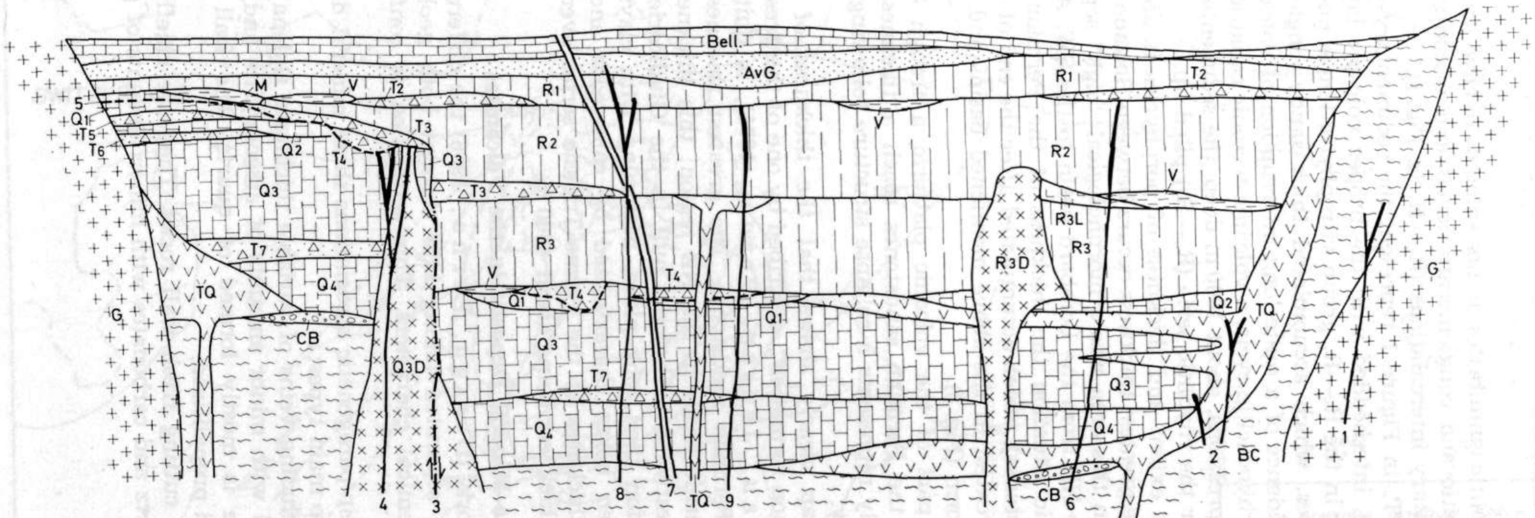


Fig. 1. Stratigraphic schema of the Permian volcanites and correlated mineral deposits in the Alto Adige region

wide layers of rhyolitic ignimbrites, minor amounts of rhyolitic lavas, thick tuffaceous-ignimbritic and conglomeratic levels and discontinous, mostly lacustrine, sedimentary intercalations (R_3—R_1 in Fig. 1).

The levels T_7—T_2 in Figure 1 represent the sedimentary-volcanic and sedimentary layers, interbedded with the proper volcanic layers. At the basis of each layer in the R_3—R_1 group vitrophyric lenses may occur (V).

Erosion processes, which accumulated thick sandy-conglomeratic deposits (T_4), give evidence of a quite long interruption of volcanic activity. At the end of this rhyodacitic cycle, a volcanic-tectonic collapse took place; in the resulting depressions, about 1000 m deep, the sedimentary Tregiovo formation and later the rhyolitic serie (R_3—R_1) piled up.

In Figure 2 the extent and thickness of porphyries in the examined area are shown. The greatest thickness occurs between Bolzano and Trento. During the Permian this area was a morphological "high" separating the Carnic basin to the NE from the Lombard basin to the SW. According to this paleogeographic situation the thickness of the Permian sandstones (Val Gardena sandstones), which accumulated after the end of the volcanic activity, became greatest in the above mentioned basins and smallest on the porphyry platform (Fig. 3).

In the central part of the volcanic platform a trough occurs near Bolzano in which the Permian sandstones reach a thickness of 200 m. The trough probably represents a collapse structure following the end of the volcanic activity.

The isopach map clearly shows that the thickness of the Upper Permian "Bellerophon formation", described by one of the present authors (Brusca, Dessau, Jensen, Perna, 1971), is quite different from that of the Permian sandstones. The greatest thickness still corresponds to the Carnic basin in the NE region; this thickness progressively decreases westward to become null in the Giudicarie area. The Triassic sedimentation then took place, beginning with clays, silts and sandstones and then being characterized by calcareous and dolomitic precipitation. The thickness of the Permo-Triassic series averages about 1500 m, the whole thickness being about 4000 m.

The Mineral Deposits in the Volcanites

In a previous work (Dessau, Perna, 1966) the different mineral deposits have been separated taking into account both geologic-stratigraphic and geochemical characters. This separation is confirmed and further proved.

According to their paragenetic associations these mineral deposits can be subdivided in two main types:

1. Stockwork including veins of variable thickness. Galena and sphalerite are associated with minor amounts of arsenopyrite and other sulphides. The gangue is mostly formed of quartz. The wall rocks are highly fractured and propylitized.

2. Veins sharply cutting fresh wall rocks. They are chiefly made of fluorite, barite, quartz and carbonates with minor amounts of galena and sphalerite.

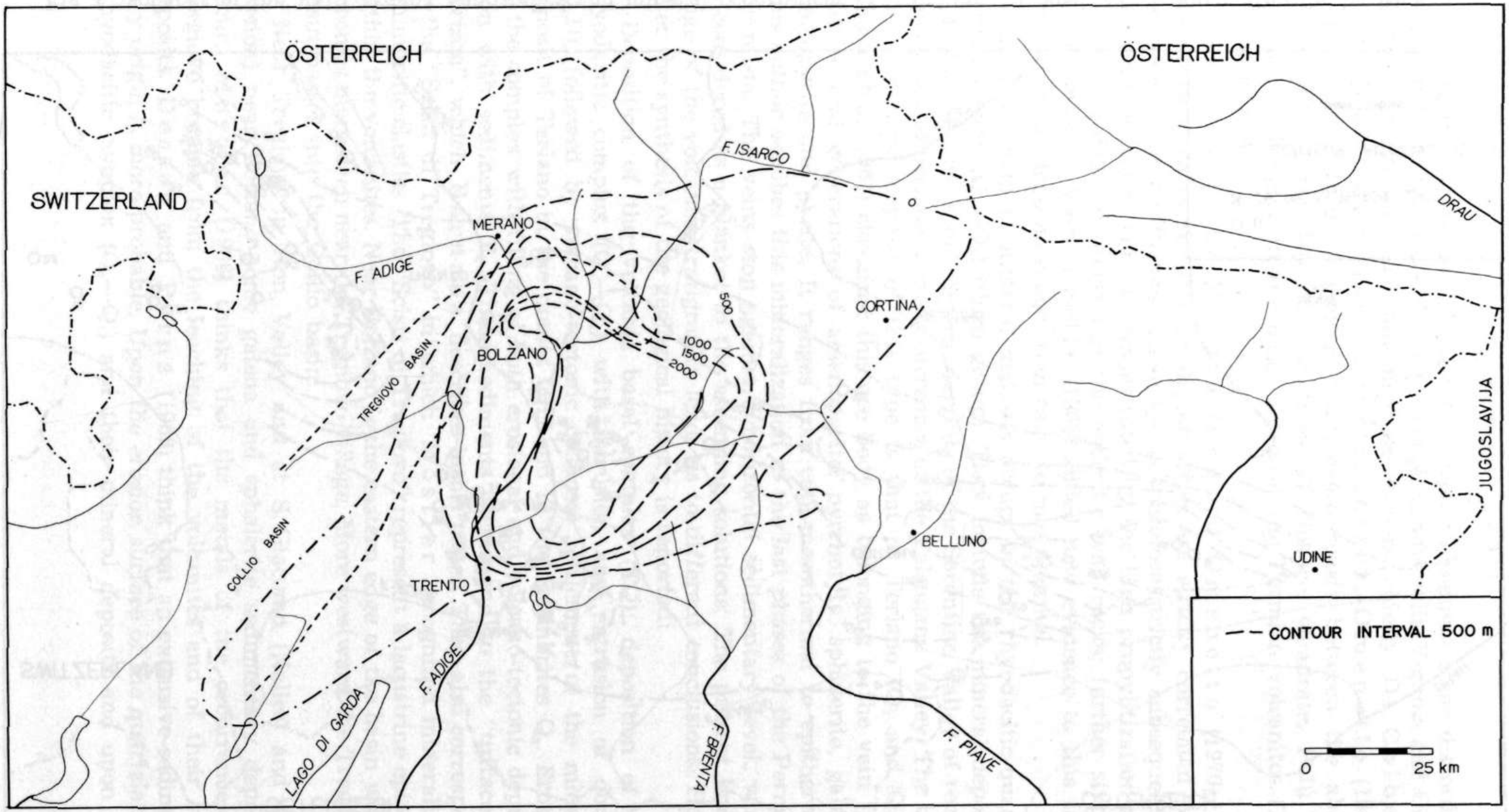


Fig. 2. Isopachs of the volcanic platform

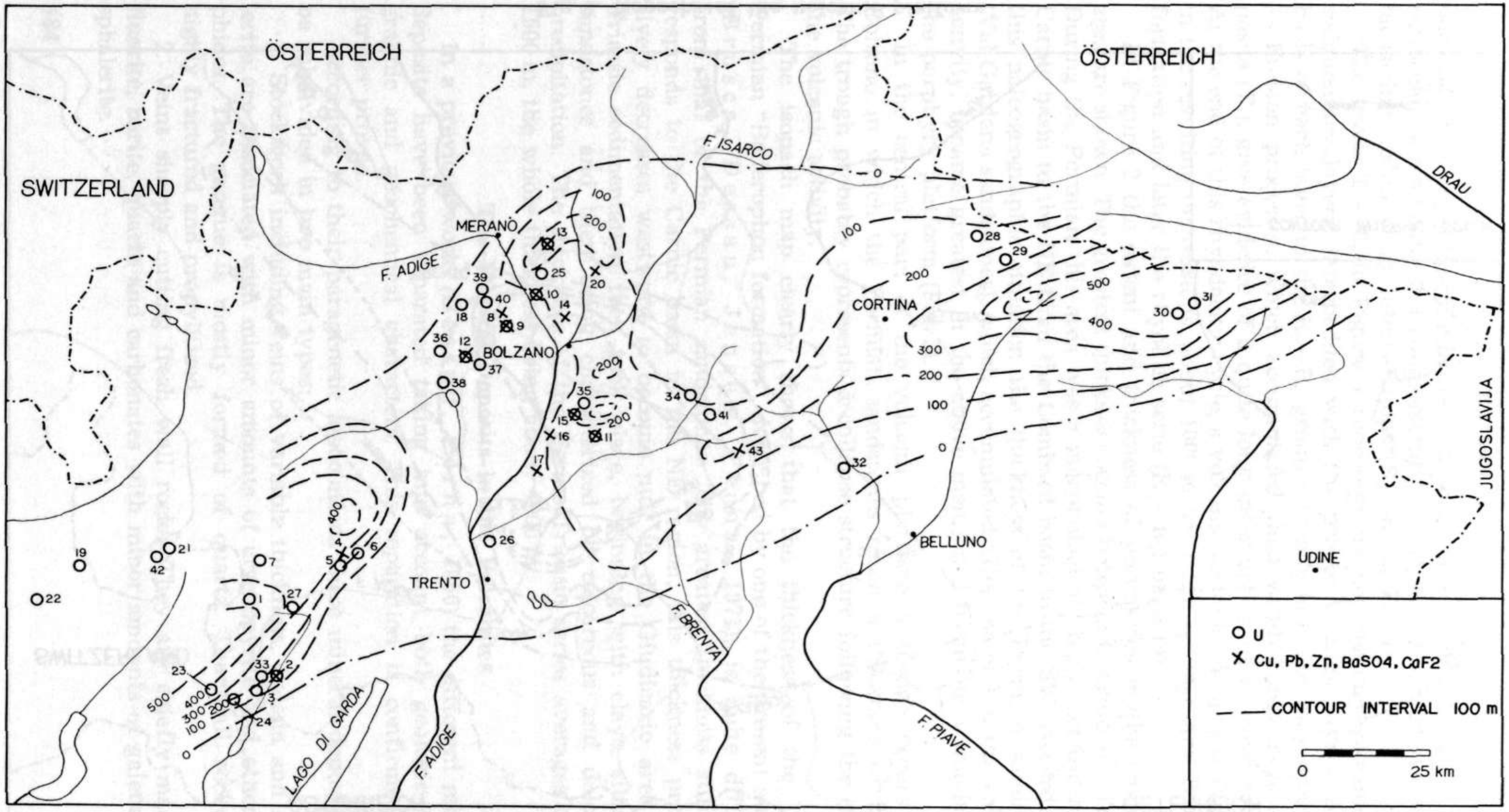


Fig. 3. Isopachs of the Val Gardena Sandstones and mineral occurrences of uranium (○); lead, zinc, copper, fluorite, barite (×)

Among the ore bodies of the metamorphic basement some discordant veins occur, for instance Valar, La Pamera, Cinquevalli, Vignola and Cima d'Orno (first group). According to some authors, chiefly Di Colbertaldo (1965b), Barillari, Jobstraibizer, Omenetto (1966), Omenetto (1970), a genetic relationship exists between the above mentioned mineral deposits and those of Nogarè, Quadrate, Palù del Fersina which occur in the basal levels of the Permian volcanites (TQ) (second group).

As demonstrated by Murara (1966) and Omenetto (1970), the mineral deposits of the basal volcanic series are strictly correlated with the same volcanic effusions. Their age is therefore strictly subsequent to the eruptive phase. This is demonstrated by the high propylitization and by the K-feldspar deuteresis of the andesitic wall rocks; further studies by D'Amico, Venturelli (1968) added new evidence to this fact. These mineral deposits range from cata- to mesothermal.

Another group of mineral deposits occurs in the rhyodacitic-quartzlatitic complex (Q_4—Q_1) (third group). They include the mineral deposits of Terlano, Nalles, some mineral deposits of the Sarentino Valley of recent discovery and perhaps some occurrences of the Valsugana Valley. The best known mineral deposit of this type is that of Terlano (Q_3 and Q_3D). Barnaba (1961) classified this ore body as belonging to the vein type with several generations of arsenopyrite, pyrrhotyte, sphalerite, galena, chalcopyrite and pyrite. It ranges from cata-mesothermal to epithermal. This author ascribes this mineralization to the last phases of the Permian volcanism. The veins stop against a horizontal sedimentary level, which is considered as a blanket to the ascending solutions. The present knowledge of the volcanic stratigraphy leads us to different conclusions. Hereafter the synthesis of the geological history is reported:

Deposition of the volcanic basal complex (TQ); deposition of the rhyodacitic complex (Q_4—Q_1) with intrusion and extrusion of domes (Q_3D), followed by volcano-tectonic collapse; settlement of the mineral deposit of Terlano in the domes Q_3D and in the ignimbrites Q_3. Erosion of the complex with filling of both erosional and volcano-tectonic depression with sediments T_4. These sediments correspond to the "tuffaceous horizon", which Barnaba describes in his paper. They also correspond to the "Scisti di Tregiovo" in which Mostler recognized mineralized ignimbritic clastics. The "Scisti di Tregiovo" represent a lacustrine episode within the volcanites. Near Bolzano is the eastern edge of the basin which becomes more deep near the Tregiovo village. More westward the Tregiovo basin passes into the Collio basin.

Near Tregiovo in Non Valley and at S. Giacomo (Nalles) and Nop (Renon) near Bolzano some galena and sphalerite sedimentary deposits occur. Mostler (1966) thinks that the metals of the occurrences of Tregiovo became from the leaching of the volcanites and of their vein deposits. Dessau and Perna (1966) think that an extrusive-sedimentary origin is more probable. Upon the erosion surface of the quartzlatite-rhyodacitic complex (Q_4—Q_1) and their mineral deposits and upon the products of this erosion (T_4), the rhyolitic volcanites are superimposed (R_3, R_1). These volcanites widespread from Merano to Trento. The Terlano and co-genetic mineral occurrences belong to an intravolcanic phase. They are therefore of Hercynian age.

The middle rhyolitic horizon (R_2) is cut by a vein of the first type (fourth group). This is the Montagiù old mine, which differs in many aspects, chiefly with regard to its paragenesis, from the more numerous veins of the central part of the volcanic platform. This epithermal deposit contains galena and quite frequent antimonial and arsenical tethrahedrites with abundant chalcopyrite (Dessau-Duchi, 1970). Maucher (1955) found the Permian Val Gardena sandstones filling an erosional hole of the vein, whose age is therefore Hercynian.

Fluorite, barite, calcite and quartz veins, with minor amounts of galena and sphalerite, cut the R_3 and R_2 levels (Fig. 1) of the rhyolitic complex (fifth group). They belong to the mineral deposits of the 2nd type. All previous authors regard these mineral deposits as of Tertiary age or, at least, of post-Triassic age (Giussani-Leonardelli, 1966a and b; Fuganti-Morteani-Vuillermin, 1966; Vuillermin 1965 and 1966). Only Dessau-Perna (1966) refer these depositions to an Upper Permian or Lower Triassic age.

In some cases these bodies cut some mafic porphyritic Ladinian dikes*.

More detailed structural studies lead to the conclusion that these fluoritic veins are strongly correlated to the recent Labinian phase (Young Labinian phase).

The evidences are the following:

a) The mineral deposits range from meso- to epithermal. Postulating a Tertiary age the superimposed pile of sediments (about 4 km) would have caused a higher and almost constant thermality among the different veins. As a matter of fact the Vallarsa and Prestavel veins are mesothermal, whereas the S. Elena vein, which is only 5 km far from Vallarsa Nord, is epithermal.

b) A vertical zoning exists with increasing barite amounts in the upper part. This zoning is very clearly repeated also in the horizontal plane going far away from the center of the mineralized zone. From Figure 4, in fact, in the marginal portion of the platform calcite and barite veins are distributed, which result separated from the fluoritic ones by a ring of fluorite and barite veins. The composition of the galena (Dessau-Perna, 1966) also reveals a slight variation in the oligo-elements content as one passes from one vein to another one.

c) Some veins, for instance the Moena, and specially S. Elena (as result of recent drilling), penetrate into the Permian sandstones (Val Gardena sandstones). They are therefore younger than Upper Permian.

---

* It was already known that the veins of Campegno mine (Bolzano) was included in a fracture together (in "composite association") with a porphyritic vein (Dessau-Perna, 1966).

d) Some veins, for example Prestavel, Pozzi, S. Elena, cut the Ladinian porphyrites*; others (Campegno and Moena) are associated with them; the fluoritic veins are therefore of Ladinian age or slightly more recent.

e) For the mineralized fractures some authors postulated a Tertiary age. Recent structural studies in this zone and in the near dolomitic mountains enabled to differentiate some complicated fields of forces, aged between the Werfenian-Anisian and Ladinian-Carnic. These fields don't occur in the Jurassic-Cretaceous sediments nearby**. In such fractures the veins of Prestavel, Pozzi and S. Elena are contained.

f) In his paper Martini (1964) reports a series of analysis of the fluorine content of the volcanites of Castelrotto. This author states that in the volcanites the fluorine content is about 345 ppm. Such a low content should be explained as an effect of the leaching of fluorine, which could have formed the fluorite veins. The high fluorine content of the stream water (Dall' Aglio, Mittempergher, Tedesco, 1966) indicates a strong present leaching of fluorine in the volcanic platform. The analysis were however performed only on a very limited portion of the volcanic series. According to the author himself the remobilized fluorine would have given an amount of fluorite 1000 times greater than that occurring in all known veins.

Emiliani-Gandolfi (1964) showed that in the granite of Predazzo, fluorite is the most abundant accessory mineral. It seems perhaps better to correlate the fluorite occurrence to the Monzoni intrusive body rather than with the Permian volcanites.

The following volcanic activity of Veneto region ranging from Eocene to Lower Oligocene, is quite displaced southwards and didn't give place to known mineral deposits (Morandi-Perna, 1970). The same is verified in the case of the Tertiary granites of Adamello and Vedrette di Ries, where no mineralization correlated with these intrusions occurs nearby.

g) The gravimetric survey reveals some positive anomalies exactly in the central part of the platform near Bolzano where fluoritic mineralizations occur. More southward and eastward a series of negative anomalies is known (Morelli-Dal Cin-Semenza, 1968). We think that these anomalies have to be correlated with a local deep magmatic body. The Triassic magmatic phenomena would represent a more eastward reactivation of the Hercynian magmatism.

The different above mentioned arguments fit well with the correlation of the fluorite deposits with the Triassic granitic center of Predazzo-

* Some samples from porphyritic veins intersected by fluorine mineralizations (Prestavel and Pozzi veins) have been analyzed after the presentation of this paper to the Symposium. The chemical analyses have shown that the porphyrites composition is rather close to that of alkali-rocks. This suggests the possibility of their correlation with the Ladinian volcanic activity since volcanites from South Tirol (ignimbrites s. l.) are calc-alkali rocks.

** Clear traces of tectonic activities related with Montenegrino-Labinian phases.

Monzoni. Such conclusion wouldn't cut out the possibility of a different origin; such as that, not too probable in our opinion, of a lateral secretion of the fluorine from the volcanites or a descent* of mineralized water from overlaying sediments.

Conclusion

As shown in the most recent studies, the mineral deposits of the Southern Alps can't be correlated with a single metallogenic Tertiary period (Alpidic age); types, genesis, geologic features, ages, paragenesis and thermality are on the contrary very different.

With this contribution, in wich data are too much summarized, an attempt has been made to improve the classification of the volcanic mineral

* From synsedimentary reactivated faults.

Explanation of Figure 4

Type 1

(Pb, Zn, Fe, Cu disseminated veins in propylitized wall rocks)

a **First group** (mineral deposits in the metamorphic basement: they are not shown in the present map)

b **Second group** (mineral deposits in the basal volcanic series): *A1* Palù del Fersina; *A2* S. Orsola; *A3* Nogarè, Quadrate; *A4* Viarago; *A5* Vallalta (mercury mine, may be remobilized or more recent); *A6* Malga Baessa; *A7* Monte Zaccon (in this group or in the fourth one); *A8* Lavarost (*A1, A2, A3, A4* are Pb, Zn, Cu mineral deposits with subordinated gangue. *A6, A7, A8* are mainly fluorite, barite, quartz veins in propylitized wall rocks)

c **Third group** (mineral deposits in the rhyodacitic-quartzlatitic series): *B1* Tires; *B2* Terlano; *B3* Nalles; *B4* Rio Danza; *B5* Palù di Tremole; *B6* Val Rabiola; *B7* Collalbo; *B8* Paneveggio; *B9* Darzo; *B10* Rio Grissiano; *B11* Val Sarentina; *B12* Rio di Nova; *B13* Lago di Cece; *B14* Ponticino; *B15* Castel Vanga; *B16* Rio del Passo; *B17* Nop; *B18* Passo di Valles; *B19* Forte Buso; *B20* Lago di Bocche

d **Fourth group** (mineral deposit in the rhyolitic series): *C1* Montagiù (occurs also U)

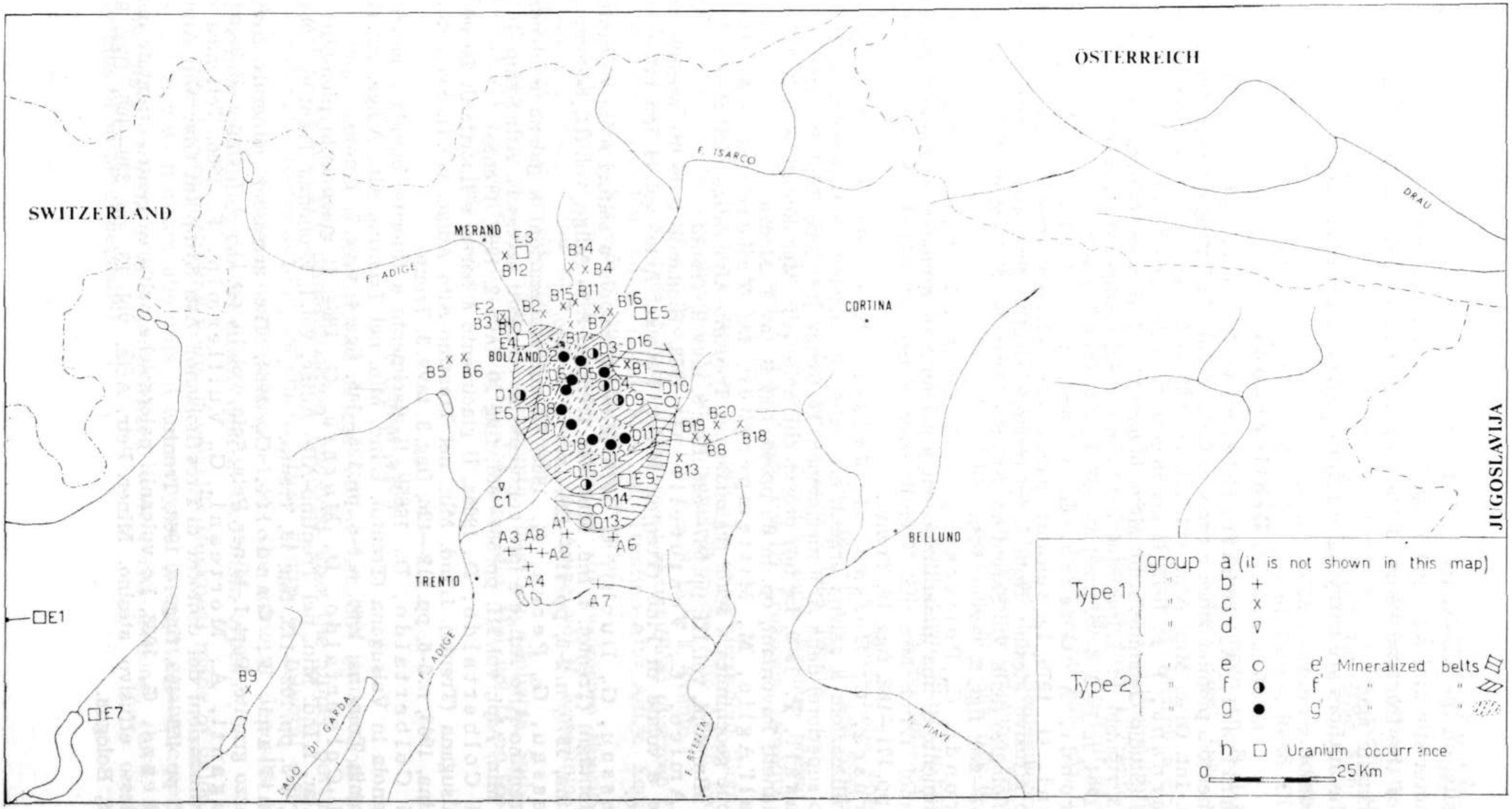
Type 2

(F, Ba veins in sharp contact with fresh wall rocks)

e, f, g **Fifth group** (mineral deposits in the rhyolitic series): *D1* Castelvecchio; *D2* Campegno; *D3* Maso Gummer; *D4* Case a Prato; *D5* Grotta; *D6* Vallarsa Nord, Wolf; *D7* Vallarsa Sud; *D8* Aldino; *D9* Masi Bianchi; *D10* Moena; *D11* Prestavel; *D12* Pozzi; *D13* Casa Bolenga; *D14* Stue; *D15* Cadino; *D16* Laste; *D17* Fontane Fredde; *D18* La Cugola. (*e* prevailing barite; *f* fluorite and barite; *g* prevailing fluorite)

e', f', g' Mineralized belts of this group; *e'* prevailing barite (and sometimes calcite); *f'* fluorite and barite; *g'* prevailing fluorite

h **Uranium occurrences** (epigenic hydrothermal-fumarolic deposits in the rhyolitic series): *E1* Novazza; *E2* Nalles; *E3* Avelengo; *E4* Maso Tinner; *E5* S. Osvaldo; *E6* Maso Ghelf; *E7* Valle di S. Martino; *E8* Montagiù; *E9* Forcella di Bombasel



Fig, 4. Distribution of hydrothermal occurrences in the Permian volcanites of Trentino-Alto Adige deposits: on the whole, five groups of mineral deposits occur with distinct characteristic and age. Particularly interesting is the chronologic attribution of the fluoritic veins of the upper volcanic complex, which resulted of Triassic age.

The authors are carrying out more exhaustive studies to get a definitive conclusion.

Bibliography

Barillari, A., Jobstraibizer, P. G., Omenetto, P. 1966, Il giacimento a piombo, zinco e rame di Cinque Valli in Valsugana (Trentino). Atti Symp. Int. Giac. Min. Alpi, vol. III, pp. 769—792, figg. 4, tavv. 4, 1968, Trento.

Barnaba, P. F. 1961, Il giacimento piombo-zincifero di Terlano in Alto Adige (Studio Geominerario). Mem. Museo Stor. Nat. Ven. Trident., anno 23-24, vol. 13, ripubbl. in: L'Ind. Min. nel Trentino-Alto Adige, vol. I, Economia Trentina, 1964, n. 1—2, 4—5, pp. 133—158, figg. 8, tavv. 5 Trento.

Brondi, A., Ghezzo, G., Guasparri, G., Ricci, C. A., Sabatini, G. 1970, Le vulcaniti paleozoiche nell'area settentrionale del complesso effusivo atesino. Nota I. Successione stratigrafica, assetto strutturale e vulcanologico nella Val Sarentina. Atti Soc. Tosc. Sc. Nat., Mem., Ser. A, vol. 77, pp. 157—200, figg. 6, tavv. 1, Pisa.

Brondi, C., Polizzano, C., Anselmi, B., Benvegnù, F. 1970, Rivenimento di una mineralizzazione a galena nelle arenarie permiane di Nalles (Bolzano). L'Ind. Min. nel Trentino-Alto Adige, vol. III, Economia Trentina, 1970, pp. 171—182, figg. 19, Trento.

Brusca, C., Dessau, G., Jensen, M. L., Perna, G. 1971, Le mineralizzazioni a galena argentifera nella «Formazione a Bellerophon» (Permiano superiore) delle Alpi meridionali. II. Symp. Int. Giac. Alpi, in print.

Casati, P. 1969, Le fasi orogeniche nelle Alpi Meridionali. Arti Grafiche Artigianelli Pavoniani, op. in 8°, pp. 49, figg. 8, tav. 1, Monza.

Dall'Aglio, M., Mittempergher, M., Tedesco, C. 1966, Prospezione geochimica a scala regionale nel Trentino-Alto Adige. Atti Symp. Int. Giac. Min. Alpi, vol. III, pp. 567—586, figg. 8, tavv. 2, Trento.

D'Amico, C., Venturelli, G. 1968, Riodaciti e rioliti atesine in cupole e colate di Pinè (Trento). Miner. Petrogr. Acta, vol. 14, pp. 143—170, Trento.

Dessau, G., Duchi, G. 1970, Mineralizzazioni a solfuri nelle vulcaniti del Montagiù (Trento). L'Ind. Min. nel Trentino-Alto Adige, vol. III, Economia Trentina, 1970, n. 2-3, pp. 115—123, tavv. 4, Trento.

Dessau, G., Perna, G. 1966, Le mineralizzazioni a galena e blenda del Trentino-Alto Adige e loro contenuto in elementi accessori. Atti Symp. Int. Giac. Min. Alpi, vol. III, pp. 587—687, figg. 20, tavv. 2, 1968, Trento.

Di Colbertaldo, D., 1965a, Il giacimento a barite e fluorite di Zaccon in Valsugana (Trento). L'Ind. Min. nel Trentino-Alto Adige, vol. II, Economia Trentina, 1965, n. 5-6, pp. 119—126, figg. 3, tavv. 3, Trento.

Di Colbertaldo, D., 1965b, Il giacimento a fluorite, blenda e galena di Vignola in Valsugana (Trento). L'Ind. Min. nel Trentino-Alto Adige, vol. II, Economia Trentina, 1965, n. 5-6, pp. 135—145, figg. 4, tavv. 7, Trento.

Di Colbertaldo, D., Murara, G. 1964, Il giacimento piombifero di Valar. L'Ind. Min. nel Trentino-Alto Adige, vol. I, Economia Trentina, 1964, n. 1-2, 4-5, pp. 102—115, figg. 13, Trento.

Emiliani, F., Gandolfi, G., 1964, The accessory minerals from Predazzo granite, Part. I. Miner. Petr. Acta, vol. 10, pp. 111—127, figg. 2, Bologna.

Fuganti, A., Morteani, G., Vuillermin, F. 1966, Tettonica e mineralizzazioni dei dintorni di Tires (Bolzano). Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 459—469, figg. 14, 1968, Trento.

Ghezzo, C., 1968, Le vulcaniti paleozoiche nell'area centro-orientale del complesso effusivo atesino. Miner. Petr. Acta, vol. 13, pp. 339—408, figg. 9, tavv. 6, Bologna.

Giussani, A., Leonardelli, A. 1966a, Le mineralizzazioni a fluorite della zona tra Cavalese e il Passo di Lavazè (Trento). Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 423—432, figg. 2, tavv. 7, 1968, Trento.

Giussani, A., Leonardelli, A. 1966b, Le direttrici tettoniche e le connesse manifestazioni a quarzo, fluorite, baritina e solfuri nei «porfidi quarziferi» della media Val d'Ega, in Alto Adige. Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 447—457, figg. 2, tavv. 2, 1968, Trento.

Martini, M. 1964, Contributo alla conoscenza della geochimica del fluoro: dosaggio nelle ignimbriti del Trentino-Alto Adige. Accad. Lincei, Rend. Cl. Sci. Fis., Mat., Nat., Ser. VIII, vol. 36, fasc. 3, pp. 400—417, figg. 3, Roma.

Maucher, A., 1955, Erzmikroskopische Untersuchungen an Blei-Zink-Lagerstätten im Raume von Trento (Norditalien). Mitteil. Geol. Ges. Wien, Bd. 48, pp. 133—153, figg. 1, tavv. 4, Wien.

Morandi, N., Perna, G. 1970, Il marmo grigio perla (marmo a brucite) nelle province di Trento, Vicenza e Verona. L'Ind. Min. nel Trentino-Alto Adige, vol. III, Economia Trentina, 1970, n. 2-3, pp. 33—65, figg. 34, tavv. 4, Trento.

Morelli, G., Dal Cin, R., Semenza, E. 1968, Contributi geofisici con appendici geologiche. Leonardi P. in: Le Dolomiti, pp. 535—552, figg. 5, tavv. 5, R. Manfrini, Rovereto.

Morteani, G. 1966, Die Propylitisierung und die P.-T.-Bedingungen der Vererzung der »Grünen Porphyrite« der Valle del Fersina (Provinz Trient — Norditalien). Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 495—503, figg. 6, 1968, Trento.

Mostler, H. 1966, Zur Genese der schichtgebundenen Blei-Zink-Erze im südalpinen Perm. Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 349—354, 1968, Trento.

Murara, G. 1966, Le mineralizzazioni a solfuri misti nelle vulcaniti atesine, formazione andesitica, dell'alta Val Fersina (Trentino). Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 471—494, figg. 9, tavv. 3, 1968, Trento.

Omenetto, P. 1970, Il giacimento ferrifero della Pamera presso Roncegno. L'Ind. Min. nel Trentino-Alto Adige, vol. III, Economia Trentina, 1970, n. 2-3, pp. 67—98, figg. 10, tavv. 5, Trento.

Omenetto, P., Detomaso, G. 1970, Le mineralizzazioni filoniane a solfuri misti nela zona di Pinè. L'Ind. Min. nel Trentino-Alto Adige, vol. III, Economia Trentina, 1970, n. 2-3, pp. 143—170, figg. 8, tavv. 3, Trento.

Vuillermin, F., 1964, Nota preliminare su alcuni filoni quarzoso fluoritici in Trentino-Alto Adige. L'Ind. Min. nel Trentino-Alto Adige, Economia Trentina, 1964, n. 1-2, 4-5, pp. 305—321, figg. 8, Trento.

Vuillermin, F., 1965, Analisi tettonica sul giacimento fluoritico di Vignola (Trento). L'Ind. Min. nel Trentino-Alto Adige, vol. II, Economia Trentina, 1965, n. 5-6, pp. 155—160, figg. 7, Trento.

Vuillermin, F., 1966, Il giacimento fluoritico «Vallarsa Sud» nella Vallarsa di Laives (Bolzano). Atti Symp. Int. Giac. Min. Alpi, vol. II, pp. 505—525, figg. 13, tavv. 3, 1968, Trento.

SUMMARY

The Permian volcanites of Adige Valley are cut by several hydrothermal veins. The mineralization involved also the upper portion of underlaying metamorphic basement (first group of mineral deposits). According to their paragenetic associations the mineral deposits of the Permian volcanites can be subdivided in two main types:

1. Stockwork including veins of variable thickness made of galena and sphalerite with minor amounts of arsenopyrite in quartz gangue permeating higly fractured and propylitized wall rocks (second, third, fourth groups of mineral deposits).

2. Veins made of fluorite, barite, quartz, carbonates and small amounts of galena and sphalerite cutting regularly fresh rocks with sharp contacts (fifth group of mineral deposits).

The above mentioned mineral deposits are different even from the geological point of view. They can namely be related to different stages of volcanic activity. The Trentino-Alto Adige volcanites can be subdivided into a middle-lower complex and into an upper one. The former are represented by latitandesitic and rhyodacitic lavas and ignimbrites in the lower part, and by rhyodacitic ignimbrites in the upper part. The latter ones are mainly represented by rhyolitic ignimbrites.

At the end of the first volcanic stage a strong volcano-tectonic activity took place, followed by thick conglomeratic-arenaceous deposition. Such sedimentation, separating the middle-lower volcanites from the upper ones, represents a quite long erosion phase coinciding with volcanic inactivity.

The mineral deposits of the first type, characterized by sulphide abundance, cut the middle-lower volcanites. They are in turn cut by the above mentioned erosion surface which separates the groups of volcanites. The vein mineralizations characterized by fluorite abundance cut, on the contrary, the whole volcanic series. Therefore the first type of mineral deposits is of the same Permian age as the earlier volcanic activity; the second one is clearly more recent and of Ladinian age.

DISCUSSION

Maucher: Ich habe das erste Diapositiv nicht ganz verstanden, dürfte ich es noch einmal sehen, mit dem Profil durch die Porphyrgänge. In dem Schemaprofil sind die »ladinischen« Gänge eingezeichnet von der tiefsten Stelle des Profils (Phyllite) bis durch den Bellerophon-Kalk. Ist eine Stelle im Gelände bekannt, wo die »ladinischen« Gänge den Bellerophon-Kalk durchschneiden?

Bakos: I filoni mineralizzati a fluorite sono conosciuti sino alle «Arenarie di Val Gardena». Ciò si osserva, per esempio, a S. Elena (Nova Ponente) ed in agro di Moena (Val di Fassa). I filoni porfiritici ladinici sono noti nelle vulcaniti e soprattutto nella serie triassica. Recentemente sono stati individuati alcuni filoni porfiritici nella «Formazione a Bellerophon» della bassa Val di Fiemme (Monte Cucal).