

The Early History of Tremolite

Philippe Roth
Ilanzhofweg 2
CH-8057 Zurich, Switzerland

Minerals first described in the 18th century, at the dawn of the science of mineralogy, often have a muddled history of nomenclatures and type localities. Tremolite is such a species. Only a careful reading of the early mineralogical books, reports and letters can puzzle out the correct priority for this common metamorphic mineral.

Tremolite, $\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$, is a calcic amphibole commonly found in greenschist-facies to amphibolite-facies calc-silicate and in low-grade ultrabasic rocks. In the new IMA nomenclature of amphiboles (Leake *et al.*, 1997) tremolite forms part of the tremolite–actinolite–ferro-actinolite series: Whereas usually the dividing line between two species in a continuous solid solution series is set at the 50% point (Nickel and Grice, 1998), tremolite occupies only a narrow range. It is defined as having a $\text{Mg}/(\text{Mg}+\text{Fe}^{2+})$ ratio ≥ 0.9 ; actinolite has a ratio of 0.5–0.9 and ferro-actinolite has a ratio of less than 0.5. These limits are designed to satisfy the strong desire, expressed especially (but not solely) by metamorphic petrologists, to retain the distinction of *green* actinolite from *colorless* tremolite (Leake *et al.*, 1997). Another reason is that tremolite is an important mineral in the definition of metamorphic zones (see below), and the diagnostic color distinction so useful in the field is entrenched in the literature; a change in the definition of the mineral would have complicated the application of important previously published studies.

Tremolite was first described as a new species in the late 18th century. It is the earliest of the still-valid species for which the type locality is in Switzerland. The name of the species is etymologically derived from the *Val Tremola*, a valley in the canton Tessin. However, tremolite has never been found in that valley. A study of the early literature and of the specimens preserved in old collections has clearly shown that the true type locality is the Triassic dolomite of Campolungo, Tessin (Stalder *et al.*, 1998) (see Fig. 1), an area also famous for the large corundum crystals first found there in the mid-19th century (e.g. Rovetti *et al.*, 1994). Figure 2 shows the location of both Val Tremola and Campolungo, and traces the limits of the possible occurrence of tremolite in the carbonate rocks of the region (after Trommsdorff, 1966), the degree of metamorphism progressively increasing from north to south until it reaches a peak north of the so-called Insubric Line. As can be seen from Figure 2, the small Tremola Valley lies to the north of this line of first occurrence, confirming the local field observations that tremolite does not occur there.

While the absence of tremolite in the Tremola Valley is generally accepted, a considerable amount of confusion exists regarding who first introduced the mineral name into the mineralogical community. Whereas a few authors mention de Saussure (1796) (e.g. Stalder *et al.*, 1998), some quote Höpfner (1790) (e.g. Nickel and Nichols, 2003; Strunz and Nickel, 2001) while others, the majority, attribute the origin to Pini (1781) or Pini (1784) (Dana, 1896; Studer, 1863; Koenigsberger, 1919; Gübelin 1939 or Carozzi, 1990) or even Pini *in de Saussure* (Dana and Brush, 1872; Clark, 1993; Blackburn and Dennen, 1997).

De Saussure, in his famous *Voyage dans les Alpes* (1796), does indeed describe tremolite; he even mentions five different varieties, but the great Geneva scholar refers in his description to a book by Berthoud van Berchem and Struve: *Principes de Minéralogie* (1795). Berthoud van Berchem and Struve, Dutch and Swiss mineralogists respectively, had traveled the Alps and assembled a collection of St. Gotthard and Mont Blanc minerals. Between 1787 and 1789 they were in Freiberg, listening to A.G. Werner's lectures, translating into French his famous and influential *Von den äusserlichen Kennzeichen der Fossilien* (1774) (Guntau, 1981-1982), and having Werner, the most renowned mineralogist of the time, identifying part of their Alpine collection (Studer, 1863). The translation was finished in 1789 but because of the great political troubles in Europe and especially in France, it did not reach print until 1795 in Paris. Although Werner's original 1774 treatise did not include tremolite, the *Principes de Minéralogie*, which is not a pure translation but an updated adaptation with additions by Werner's former student, D.L.G. Karsten, does include a description of three different tremolite varieties.

Should Berthoud van Berchem and Struve therefore be considered the authors of the first official description of tremolite? No, because several treatises and magazine articles had used the name before 1795. A (probably incomplete) list of early references to the name "tremolite" is given in Table 1 (the designation for the mineral, the locality and the host rock, respectively are added):

Table 1. Early references to the name "tremolite."

- (1794) Johann Friedrich Wilhelm WIEDENMANN's *Handbuch des oryctognostischen Theils der Mineralogie*. "Tremolit" – "Valle Tremola" and Transsylvania – fine grained limestone.
- (1793) Ludwig August EMMERLING's *Handbuch der Mineralogie*. "Tremolith" – close to "Val Tremola," "Urserthal" and Transylvania – coarse limestone.
- (1792) Louis Benjamin FLEURIAU DE BELLEVUE's "Sur le marbre élastique du St. Gotthard." *Journal de physique*, **41**, 86-91. "Trémolithe" – "Campo-Longo" – marble.
- (1791) Johann Frierich BLUMENBACH's *Handbuch der Naturgeschichte* (4th ed.). "Tremolit" – "Thal Tremola" – sand-like marble earth.
- (1791) Abraham Gottlob WERNER's *Ausfuhrliches und sistematisches Verzeichnis des Mineralien-Kabinetts des weiland kurfuerstlich saechsichen Berghauptmans Herrn Karl Eugen Pabst von Ohain*. "Tremolith" – Switzerland – fine grained limestone.
- (1790) Johann Friedrich GMELIN's *Grundrisse der Mineralogie*. "Tremolit" – "Thal Tremola."
- (1790) Johann Georg Albrecht HÖPFNER's letter to the editor published in Crell's *Chemische Annalen*, 1790(1), 54-57. "Tremolith" – "Gotthardt."
- (1789) Johann Jakob FERBER's *Drey Briefe mineralogischen Inhalts, an Freyherrn von Racknitz*. Mylius, Berlin. "Tremolit" resp. "Höpfnerit" – "Valle Tremola."
- (1789) Johann Georg Albrecht HÖPFNER's **I**. "Ueber die Klassifikation der Fossilien in einem Schreiben des Herausgebers an Herrn Dr. Karsten in Halle." **II**. "Versuch einer neuen Classifikationsmethode der Stein und Erdarten, nach den neuesten chemischen Erfahrungen." In: *Magazin für die Naturkunde Helvetiens*, **4**, 255-332. "Tremolith" – "Gotthardt."
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Despite the fact that his name is so commonly associated with tremolite, no work of Pini appears in this list. Ermenegildo Pini (1739–1825) was an Italian priest and Professor of Mathematics and Natural History at the San Alessandro College in Milan and the official *scientific delegate for mining* in what was then Austrian Lombardy. He had traveled the Gotthard area for the first time in 1780 and published his observations one year later in his *Osservazioni mineralogiche sulla montagna di S. Gottardo*. This work, incidentally, contains the first description of "adularia," now considered to be a more or less transparent variety of orthoclase.



Figure 1. The impressive fold of Triassic dolomite at Campolungo, seen from the east. Photo by N. Meisser.

Pini made a second trip to the area a year later and again published his observations, in 1783 (see Table 2). Both works were translated into German. He further wrote a supplement a year after. None of these works contains the name tremolite. In his reports Pini complains about the bad weather that prevented him from visiting more places; Campolungo is not a locality he mentions or otherwise describes in his memoirs. In a later work published in 1786 (see Table 2), Pini for the first time published a few lines on a new unnamed mineral which, based on this short description, appears to have been tremolite. In 1790, by which time the term “tremolite” had started to gain acceptance (see above), he more thoroughly described the Campolungo dolomite outcrops and clearly identified tremolite among their constituent minerals. However, he designates tremolite as *scerlo bianco*, “white schörl,” and gives only a vague locality designation as *Valle Maggia* (see map in Figure 2).

Table 2. Early works by Ermenegildo Pini.

- (1781) “Osservazioni mineralogiche sulla montagna di S. Gottardo.” *In: Opuscoli scelti sulle scienze e sulle arti* 4.
- (1783) *Memoria mineralogica sulla montagna e sui contorni di S. Gottardo*. Milano, Marelli.
- (1784) *Mineralogische Beobachtungen über den St. Gothard*. German translation by Adolf Beyer, Schneeberg of the 1781 work.
- (1784) *Ueber den S. Gotthardsberg und seine umliegenden Gegenden*. German translation published in Vienna of the 1783 work.
- (1785) “Supplemento alle osservazioni sulla montagna di S. Gottardo.” *In: Opuscoli scelti sulle scienze e sulle arti* 7, 124-128. Supplement to the 1783 work.
- (1786) “Osservazioni sui feldspati ed altri fossili singolari dell'Italia.” *In: Memorie di matematica e fisica della Società italiana*, **3**, 688-717.
- (1790) *Di alcuni fossili singolari della Lombardia Austriaca e di altre parti d'Italia*. Milano, Marelli.
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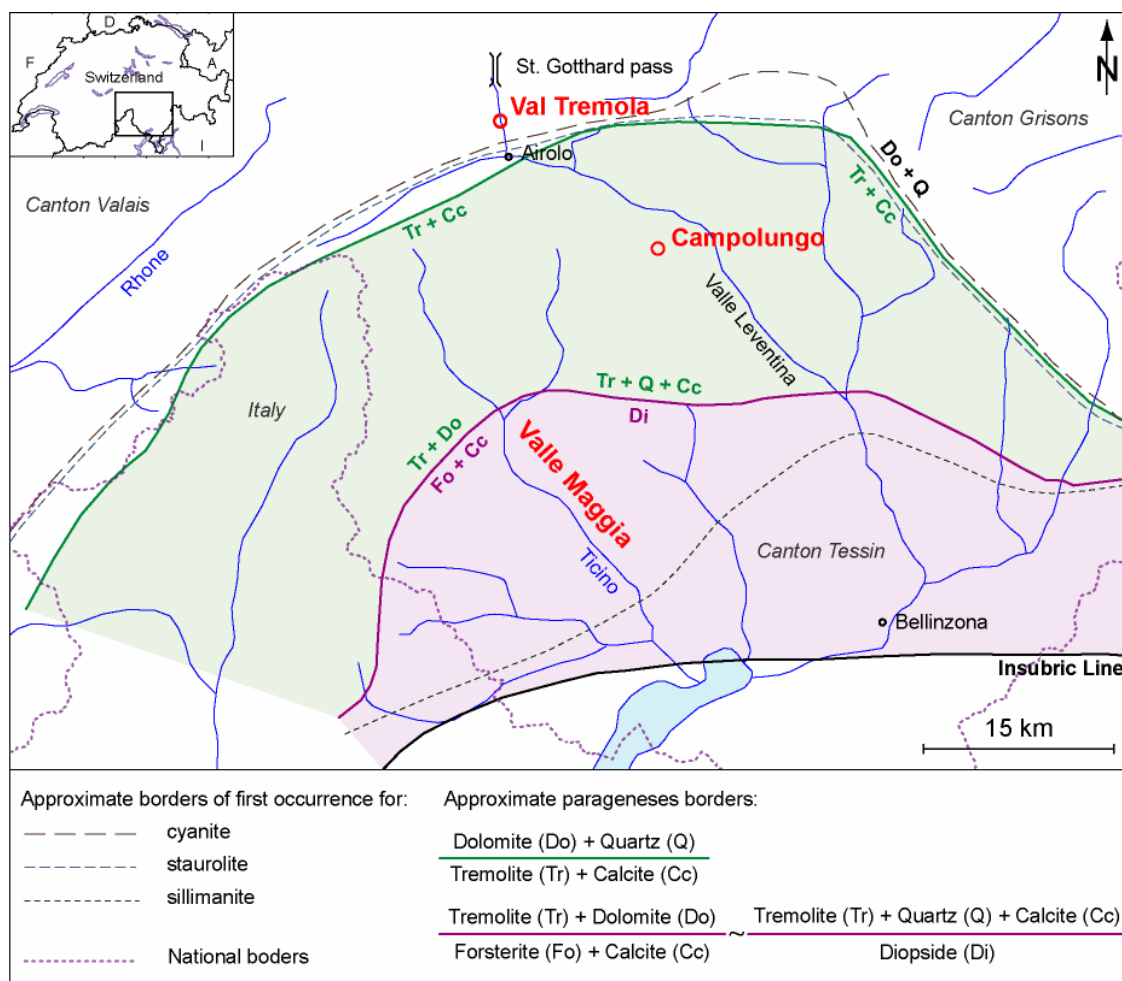


Figure 2. Map of the northern part of canton Tessin. The degree of Alpine metamorphism progressively increases from north to south to reach a maximum north of the Insubric Line. Tremolite only occurs south of the thick green line. The Tremola Valley lies north of this line. The localities mentioned in the early literature as tremolite localities are marked in red. Modified after Trommsdorff (1966).

As seen from Table 1, the 1789 article by Höpfner contains the earliest mention of tremolite. Johann Georg Albrecht Höpfner (1759–1813) (Fig. 3) was a pharmacist and later a journalist and owner of a reading cabinet in Berne. He was the publisher of the *Magazin für die Naturkunde Helvetiens*. With a call for comments (*Preisfrage*) on the origins of basalt, he was highly instrumental in stimulating the great debate between neptunists and plutonists. Having studied Alpine geology and petrography and made his own observations, he despised to a certain degree the overwhelming authority of Werner (who had never visited the Alps). This attitude, in turn, was vehemently criticized by a few Wernerian scholars. In an answer to these critics, and to illustrate that all rocks were probably not already known as Werner had claimed, he mentions in his 1789 work that:

On the one hand, the five new fossils [=minerals] we found last summer on the Gotthard and the rock in which the **tremolite** occurs give good reasons to expect even other, yet unknown rocks to be found.

Höpfner (1789), *Magazin für die Naturkunde Helvetiens*, **4**, p. 268. [All quotations are the translations of the author]



Figure 3. Miniature portrait of Johann Georg Albrecht Höpfner (1759–1813), date and artist unknown; private collection. Bürgerbibliothek Bern, Neg. 5590.

In his own classification of minerals, comprising the second part of this article, Höpfner lists tremolite from the Gotthard area and gives the results of a chemical analysis performed by Struve. One year later, in 1790, in a letter to Crell, the publisher of the *Chemische Annalen*, Höpfner again quotes tremolite from the Gotthard area and presents the Struve analysis as well as a new one by Klaproth. He writes that:

I can communicate a few mineralogical news items, provisionally, as the fifth volume of the Magazine [=Magazin für die Naturkunde Helvetiens] will contain the external [=physical] description and complete analysis of the new fossil [=mineral] species, which my local friends and I have discovered on the Gotthard and on other mountains in Switzerland. [...] Besides this oryctognostic description and the mineralogical analyses, the story of the discovery of each fossil [=mineral species] as well as its birthplace will be added.

Höpfner (1790), *Chemische Annalen* 1790(1), p. 54 & 57.

However, because of emerging financial problems (Fankhauser, 1920) and probably also because of the unexpected intensity of the controversy and polemics he had triggered, a fifth volume of the *Magazin* was never published and Höpfner's promise was never fulfilled. Johann Jakob Ferber, the famous Swedish mineralogist and indefatigable traveler, happened to be in Switzerland at that time. He met Höpfner in Bern. In a letter to von Racknitz (Ferber, 1789) he sheds some light on the discovery :

Herr Höpfner had acquired from the crystal diggers at the Gotthard what, based on its external appearance, looked to be a coarse amianth from the Valle Tremola which he wanted to call **tremolite**, and his friends höpfnerite, and which prof. Klaproth, based on the ratio of its constituents, had found in his analysis to be different from the other amianths.

Ferber (1789), *Drey Briefe mineralogischen Inhalts, an Freyherrn von Racknitz*, p. 22.



Figure 4. Label accompanying a tremolite specimen from Campolungo in the Struve collection, now in the Musée Cantonal de Géologie in Lausanne. Photo by S. Ansermet, courtesy of N. Meisser



Figure 5. Tremolite specimen from the type locality in the Struve collection, Musée Cantonal de Géologie in Lausanne. Photo by S. Ansermet, courtesy of N. Meisser

From all this we can conclude that not Pini, nor de Saussure but Höpfner introduced the name “tremolite” into the literature. Whether the Gotthard *strahlers* deliberately misled their clients by giving an erroneous locality in order to keep secret the true source (as was later done for milarite, named after the Val Milar but actually found in the Val Giuv; Moore, 2004) is unknown, but does not seem probable, owing to the large quantity of available material in Campolungo. One can also speculate about the identity of the friends who traveled with Höpfner and who are mentioned both by Höpfner himself and by Ferber. It is tempting to consider that they might have been Struve (who performed one of the first two analyses of tremolite) and Berthoud van Berchem.

We do not know what ultimately became Höpfner’s mineral collection. Höpfner was most probably forced to sell it because of his financial problems. No specimen in the Natural History Museum in Berne can be traced back to him (H. A. Stalder and B. Hofmann, personal communications, 2006). On the contrary, the collection of Henri Struve is preserved in the Cantonal Geology Museum in Lausanne, where Struve’s specimens are still identifiable as such (N. Meisser, personal communication, Fig. 4 and 5). The tremolite specimens are accompanied by labels written by Struve himself and are unambiguously tremolite. Therefore, there is no doubt that Höpfner’s and Struve’s tremolite is the same mineral as the one we know today under this name. De Saussure’s collection is also preserved, in the Natural History Museum in Geneva, and contains what is considered until now to be the type specimen of the species (CTMS, 2004).

The relative inaccuracy of 18th century chemical analyses and the high proportion of impurities included in the tremolite crystals from Campolungo (already noticed by the early authors) can explain, at least in the case of Struve's analysis, the difference with modern results, as shown in Table 3, which compares Struve's and Klaproth's analyses of Campolungo tremolite with two modern analyses by Bianconi (1971). Recent, not yet published investigations performed in Lausanne by Thomas Müller, a PhD student, have shown the Campolungo tremolite to contain considerable amounts of fluorine, replacing OH⁻. The last column on Table 3 shows the average of 39 point-analyses performed, eight of which are in the field of the potentially new fluorine analog of tremolite, called “fluortremolite” by Valley et al. (1982). The structural formulae for the high fluorine (fluortremolite) and the high hydroxyl (tremolite) analyses are (Ca_{1.99}Mg_{5.00})Si_{7.85}Al_{0.13}O₂₂[F_{1.06}(OH)_{0.94}] and (Ca_{2.01}Mg_{5.55}Na_{0.13})Si_{7.55}Al_{0.14}O₂₂[(OH)_{1.19}F_{0.80}], respectively.

Table 3. Analyses of tremolite.

	Struve in Höpfner (1790)	Klaproth in Höpfner (1790)	Bianconi (1971)	Bianconi (1971)	Univ. Lausanne (unpubl.)
SiO ₂	55.75	65	58.0	54.0	53.2
CaO	10.25	18	13.2	11.9	13.0
MgO	13.5	10.3	22.1	18.2	24.5
FeO		0.15	0.2	0.2	0.1
Al ₂ O ₃	8.5		3.1	9.8	0.7
Na ₂ O			0.5	1.4	0.5
K ₂ O			0.1	0.2	0.1
Others			1.0	3.7	2.1
H ₂ O & losses	12.0	6.5	1.8	1.3	5.8
	100.0	100.0	100.0	100.7	100.0



Figure 6. Tremolite colored in green by inclusions of chlorite particles, from Val Maighels, Grisons, Switzerland. Photo by T. Schüpbach.

Höpfner was not aware of the correct locality for his new mineral. As already mentioned, the first complete description of the Triassic dolomite locality of Campolungo was given by Pini in 1790, even if he only vaguely spoke about *Valle Maggia* (see map in Fig. 2). Detailed and geographically correct descriptions of the tremolite type locality later appeared in Fleuriau de Bellevue (1792) and in de Mechel (1795) (see Table 1), the latter with a map of the area by Exchaquet and a catalog of the Gotthard minerals by Berthoud van Berchem and Struve.

To be complete, we need to add that, for mineral species discovered before the 20th century, the first scientist to have described a new mineral is often not the person with whom we associate the species today. This happens when the earliest description employs a name for the mineral which is not recognized today. Such is the case for tremolite: Johann Ehrenreich von Fichtel had already described tremolite from Sebeșu de Jos, Transsylvania, Romania in 1782. However, he named the mineral *Säulenspath* and *Sternspath* (Fichtel, 1782). The introduction of the currently accepted mineral name, however, is the one that counts, and in the case of tremolite we have shown here that the correct reference is Höpfner (1789).

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FOLLOW-UP NOTE, January 2008

The attention of the author was recently drawn to a paper published in 1809 by the famous German geologist Leopold von Buch. Von Buch described occurrences of tremolite in northern Europe, and opened his article with a paragraph which sheds an interesting light on the naming of the species. Von Buch wrote as follows, 20 years after Höpfner's first mention of the name tremolite:

When, about twenty years ago, tremolite was found in the high, almost inaccessible rock cliffs of *Campo Longo*, opposite to the *Gotthardt pass*, such a fossil [= mineral] was little known from other localities. People were delighted about and amazed by the beauty of the new product, and the demand it triggered was high. This raised the wish of the discoverer, probably a farmer in *Airolo* or in *Fontana*, to remain in the exclusive possession of its sales and when one asked the specimen dealer *Vizard* in *Berne* through whom at that time the fossils from the *Gotthardt* were made popular where the new fossil came from, he would mention the *Val Tremola* as its birthplace. Thus the name tremolite was adopted, irrespective of the fact that no trace of the mineral exists in *Val Tremola*. However, the regions of the *Gotthardt* were soon explored more thoroughly; mineralogists scaled the cliffs of *Campo Longo* themselves; and tremolite was also found in other European localities.

Von Buch L. (1809): *Der Gesellschaft naturforschender Freunde zu Berlin Magazin für die neuesten Entdeckungen in der gesammten Naturkunde*, **3**, p. 172

This indicates that the farmer/Strahler indeed deliberately specified an erroneous locality in order to protect "his" true source and the associated financial revenues (this could not last long however, owing to the easily recognizable appearance of the sugary dolomite matrix and to the abundance of tremolite in Campolungo). Höpfner, who bought tremolite specimens either in Berne or, more probably, in the region of Campolungo, was misled, naming the new species in 1789 on the basis of this erroneous indication. The article by von Buch shows that the error was already known and publicly reported in 1809. However, 200 years later a few treatises and databases still designate Val Tremola as the tremolite type locality.

I wish to thank Eric Asselborn, who directed my attention to von Buch's article, and to Wendell Wilson for accepting this addendum to my original text.

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