The silver mines of Tretto
(Vicenza - Italy)

Foreword

This work describes the research carried out in the silver mines of the small Tretto plateau; this area is surrounded by the relieves of the Schio territory (Pre-alps in the northwest Italy, province of Vicenza).
In the Tretto area there are ore bodies of lead, zinc and silver, clays and barite; these deposits are genetically linked to an important Ladinian magmatic phase (Middle Trias).
The Tretto silver mineralizations were highly exploited, in particular between the xv and xvi centuries, under the Venetian Republic rule; the mining and metallurgic industry of this period achieved remarkable levels, in particular after the introduction of technical innovations such as the silver amalgamation, and the gun powder blasting.
Today some mines remain as evidence of this "mythical" silver age; they are partly occluded or inaccessible. The Equipe Veneziana di Ricerca in cooperation with the Gruppo Speleologico Padovano has explored and studied them.

The historical background

The Vicenza Alps metalliferous mineralizations had been renowned in ancient times and either the Paleovenetians and the Romans had exploited them, the proofs are the remains of metallurgic activity datable to the Bronze Age and the Roman period and found out near Schio and Santorso. Unfortunately the marks of this exploitation were destroyed by the subsequent farming works.
The historical data referring to the period between the XII and XIV centuries are scanty but there is the evidence of a thriving silver production.
In 1404 the Vicenza area became part of the Venetian Republic; soon the new conquerors started to take under control this mineral wealth; they gave investitures and decided precise rules for the research and exploitation of the metalliferous ore bodies even if a definite Mine Law was issued only in 1488.
The flourishing phase of the Vicenza mining activity took place between 1490 and 1525: in the Tretto this is the period of the later called "silver boom"; it has to be considered in the light of the more general European growth of the mining and metallurgic activity, due to the increasing demand of metals, copper and silver in particular, linked to the needs for the production of coins and war devices.
If on one hand the amount of silver produced in the Vicenza area can't be compared to the production of the main mining areas of the period (Central-West Germany, Tyrol and Slovakia) and, actually, it was not enough to cover the needs of the Venitian Minton; on the other hand its quality reached remarkable levels.
Between the end of XV and the beginning of XVI a massive immigration took place: skilful German and Tyrolean technicians (specialised workers, miners and smelters) went to the Tretto introducing the knowledge and experience learnt in their land of solid and old mining tradition.
In this period, in the Tretto, big mining companies opened many mines (called buse, in the Venetian dialect) and invested large capitals to search and exploit the silver ore bodies. Even wealthy Venetian merchants and aristocrats were interested in this profitable area.
Next to this main activity controlled by powerful mining companies, many farmers tried their luck and dreamt to become rapidly rich exploiting small mines with no means.
In the area of Vicenza the silver production reached its maximum levels between 1500 and 1510; in that period, on the basis of estimates on the mining taxes payed to the govern, Vergani (1995) supposes that the production was about 500 kg/year, while in 1522 it was lowered to only 120 kg. The production had always been modest, if compared to the big mining districts of that age (Schwaz in Tyrol, Schneeberg in Saxony, etc.); how-

ever it mobilized great capitals and transformed Schio into an important economic centre, with hundreds of workers.
In 1508 Pope Giulio II and some european kings, joined up in the Cambrai Leagues because they intended to share out the territories of the Venetian Republic. Between 1509 and 1517, Venice was involved in a ruinous war; during the advance of the enemy, the govern tried to disguise the signes of the rich mining activity, engaging some sappers; after the end of the war, only a few mines could be restored for the silver production.
In 1519 some vicentinian and venetian entrepreneurs founded a big company in order to resume the mining activity; they were soon followed by some little societies. According to a chronicle of 1526, at that time there were six hundreds of workers in the Tretto area.
In spite of the large availability of financial and human resources, it was not possible to reach the levels of the beginning of the century; in fact the production lowered year after year.
The introduction of innovative techniques, such as the metallurgic method of amalgamation with mercury, was not enough to save the vicentinian mining industry from a ruinous collapse, that was favoured also by the arrival of the Southamerican metals on the market.
From the thirties, the German technicians went back to their countries; the entrepreneurs retired from business, and the villagers resumed their original works; in 1549 there were only a dozen of buse left, exploited by poor farmers.
In Tretto the mines were resumed for the production of ball clay; probably the clay had always been a co-product of silver, since it wasn't subject to the mining taxes.
Between 1572 and 1575, Giovanni Battista Martinengo tried to re-activate some mines of Tretto, considered the most promising silver mines in the vicentinian area; he utilized the gun powder. The attempt failed, anyway it is very important because it is the first test of gun powder blasting in mining activity that had ever been documented.
In order to improve the vicentinian mines fortunes, in 1670 a state-controlled organization was created, with the financial support of both the govern and private investors; the explorative campaigns and the attempts to reactivate the old mines were unsuccessful and the only result was the waste of the invested capitals.
In spite of the continual failures, they kept on searching ores, attracted by the enthusiastic and excessive descriptions made by predecessors, wich helped to create the "myth of silver" and to overstimate the vicentinian mineral wealth.
In the XVIII century a few occasional prospections were made; at last every activity ceased after the fall of the Venetian Republic in 1797.

The prospection

As we have mentioned, the medioeval miners of Tretto were supported by skilled German technicians, who were able to detect every little clue of the presence of the mineralization: the silicificated limestone, the water taste of sulfur, the grey and bluish stains of secondary minerals produced by alterations.
The chronicles of that period had hand down to us stories of legendary characters such as the sorcer friar that found the silver vein using his dowsing rod and foretold the collapse of the mining activity in Tretto. Even reliable sources, such as the De Re Metallica of Agricola (1563) accurately describe the techniques of the dowsers.
There are also stories of natural phenomena such as sudden flames that, in particular nights of the year, would have shown the presence of body ores.

Mining techniques

On the basis of the observations made during our surveys, we can say tha the mines show a great variability of the dimensions of cavities: halls and galleries, that permit to walk upright, alternate to narrow and low tunnels that compell to move on all fours; the development of the mines is extremely

irregular, even tortuous for the mine of San Patrizio.
Although tunnels seem to develop at randoms, we can suppose that the progress was determined by the need to avoid the parts of very hard and resistant silicificated rock, and follow the mineralization, which is not continuous and is constituted by nodules scattered among the wall rock.
The mining tools were wedges, chisels and sledgehammers, in accordance with the techniques widespreaded in all Europe and described also by Agricola. In some mines we have observed the typical lines left on the rock by the use of these tools.
In regard with the use of fire, another method widely used at that time, we can't confirm if it was used in Tretto because we haven't found clear signs in the explorated mines.
It is importanti to underline that in 1572 Giovanni Battista Martinengo made some tests of gun powder blasting in the mines of Tretto; after this episode the method was reutilized only in 1627, in a Slovak mine by the Tyrolean technician Kaspar Weindl, who is acknowledged as the inventor (Vergani, 1991).

The ore dressing and the metallurgy

The processes of ore dressing used in Tretto were similar to those of the other European mining districts; they are well described in Agricola's work.
The digged out material was coarsely crushed and selected, separating the ore from rock. Then the minerals were milled in grinding machines with heavy iron-reinforced wood rammers moved by hydraulic wheels.
In the subsequent phase the mineral was roasted and smelted.
The smelting and the concentration of silver occurred in two stages because of the complex nature of silver mineralizations of Tretto, constituted by sulfosalts (mainly tetrahedrite). The mineral was first smelted at a temperature between 950° and 1200°C; during this process the silver alloyed itself to lead; the silver was separated from lead by cupellation, a second smelting at 1000°C in presence of forced air. The content of copper in the silver minerals often made the process difficult because these two metals have very similar melting points. The technicians used to add some lead bars to the smelted (Saiger process or liquation), separating silver form copper because silver alloys itself more easily to lead.
Furthermore in Tretto it was tested silver amalgamation with mercury at industrial levels. The birth of this productive method is commonly attribuited to the Mexican Bartolomè de Medina, in 1556,but some documents of that period indicate that silver amalgamation was used in Tretto in 1507.

Geology and mineralizations of Tretto

In geological literature the area of Tretto is included in the "Recoarese", an area that constitutes the most southern part of the South-alpin complex. In the surrounding territory there are more recent formations, while in the Recoarese the erosion of an anticline, belonging to a folding with ENE-WSW axis (referable to alpine orogenesis), had allowed the outcrop of metamorphic Paleozoic rocks and of the sedimentary permo-mesozoic covering.
The permo-trias sedimentary succession of the Recoarese reflects the paleogeographic position of this area: the reduced thickness and the stratigraphical hiata, and other important elements, are the expression of the proximity to a wide land above sea level, at south.
During Trias, the Recoarese is characterized by shallow basins in which the relative sea level oscillations have left considerable traces.
During Trias and during Tertiary important volcanic phases characterize the Recoarese.
The origin of the lead-zinc-silver mineralizations is linked to the Ladinian magmatism (Middle Trias); the sulfur and the metals are bounded to the residual fluids of the crystallization of the deep magmatic masses (Frizzo et alii, 1982). The de-

velopment of convective systems, with mixing of magmatic and meteoric waters, has caused a diffused hydrotermalism, that has produced clayey alterations of volcanic rocks and the precipitation of sulfides, guided by chimical-physical gradients, in the sedimentary rocks.

During the explorations of the mines, some mineralized rock samples have been picked up, and have been studied by means of a reflected light - microscope and analyzed with electronic microprobe, in the laboratories of the Department of Mineralogy and Petrology of the University of Padua (Perissinotto, 1999).
This study demonstrates that the mineralizations of Tretto are constituted by a low temperature paragenesis (epithermal phase, about 120°C) with pyrite, galena, blende, chalcopyrite, often in combination with marcasite and tetrahedrite, in gangue of barytes, quartz and carbonates. In some cases there are minerals such as tennantite, pyrargirite, pearceite, polybasite, enargite, Ni-pyrite. Secondary minerals are cerussite, anglesite, smithsonite, covelline, malachite, azurite.
The greater holders of silver are sulfosalts, among which the most widespread is tetrahedrite.
The tretrahedrites have a very variable content of silver, even in a single mine; it varies from less than 1% Ag to about 21% Ag. In some sites there are sulfosalts such as polybasite (71% Ag), pyrargirite (60% Ag), pearceite (63% Ag); they are rare but rich of silver. Only in one case poor silver tennantite has been found (average content of 0,3% Ag).

The ancient mines

As stated in the historical description, the silver mines, exploited from XV to XVIII century, were often resumed in more recent periods for the production of ball clay; therefore the ancient traces of mining works sometimes had been spoiled. Some cavities were substantially extended and this altered the original morphology.
In some lucky cases, the presence of the signs of chisels on the rock, or the finding of ceramic potsherds have permitted us to date the mines to the Middle Age.
The most interesting cavity is the mine of San Patrizio, that has a development of more than 1100 meters and is characterized by an intricate network of tunnels, represented also in an evocative map in 1681.