



WHITE PAPER

**ZINC-LEAD EXPLORATION AND MINING IN THE BERGAMESQUE REGION
OF NORTHERN ITALY**

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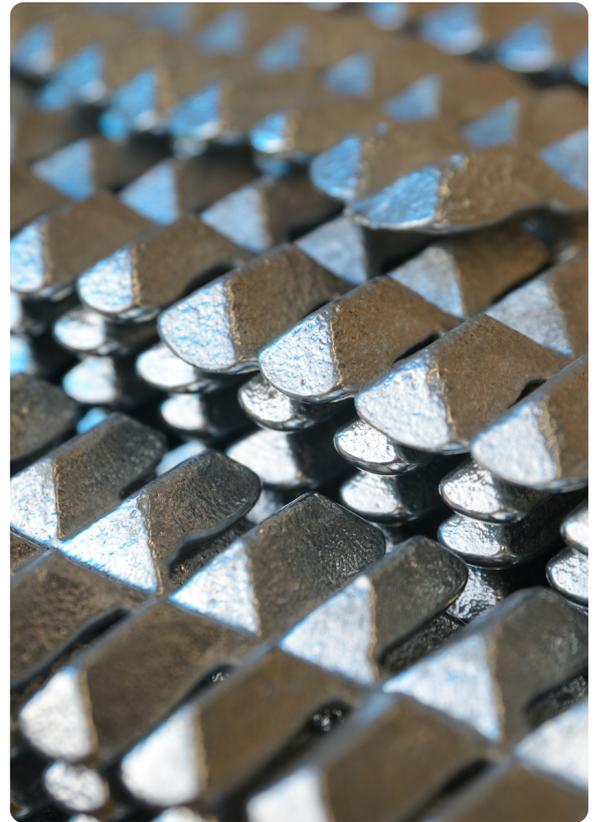
Background

Where did the Romans get their zinc?

Although brass, a gold-coloured alloy of copper and zinc (called Aurichalcum in Latin), was well known before Roman times (the oldest brass objects known so far from Italy are two Etruscan finds preserved in the British Museum¹), it was the Romans who placed it at the forefront of monetary policy and military power.² The location of Roman zinc ore mines has been notoriously difficult to trace, as slag, a typical indicator of metal production, is absent, and it has been generally accepted that the zinc came from mines in Germania.

One of the only written sources available from the Roman period is the Natural History of Pliny the Elder (Book XXXIV, Chapter 2), who was born in the Bergamesque region of northern Italy, near Como. Pliny talks about cadmea mined in the region, which is synonymous with calamine, a historical term for secondary zinc ore consisting mainly of the minerals smithsonite, hemimorphite and hydrozincite.² The word "calamine" is no longer in general use today.

The beginnings of the use of brass by the Romans in the southern Alps dates from around 60 BC, and the first Roman brass coinage was minted around 45 BC by Julius Caesar, and it is thought that this minting of brass under Caesar began in Cisalpine Gaul at Milan.³ If this is correct, the choice of northern Italy for the production of the first brass coins could be related to the city's close geographic proximity to zinc sources in the Bergamesque Alps.



Merkel² proposes, through his archaeometallurgical analysis of ore and brass, that the Gorno ore district has the potential of being an important source of zinc ore, for example, for the production of 2nd Century brass sestertii minted in Rome. Although requiring further analysis, Merkel² proposes that his study provides a theoretical foundation for the interpretation of the lead isotope ratios of Roman brasses.

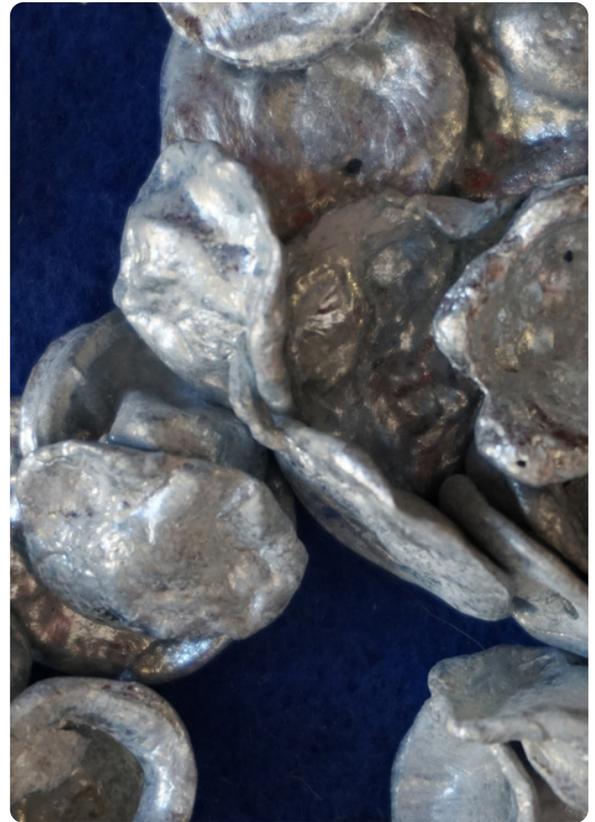
More recently, the underground zinc mine at Gorno was operated by the Italian Hydrocarbon Authority, Ente Nazionale Idrocarburi (ENI), from 1888 until 1982, yielding reported mine production of 6 million tonnes grading at 14.5% zinc + lead, which resulted in the production of high-quality 55–60% zinc sulphide concentrates.

Mining activities peaked during the 1970s, when many of the underground drives and areas of stoping that had been developed for zinc oxide ore were transitioning to sulphide ore mining, with underground drilling having delineated extensive zinc-lead mineralisation. A substantial tonnage of this undeveloped mineralisation was intended to be brought into production, but in the 1980s, ENI closed most of its base metal operations (including Gorno) to focus on its core business of hydrocarbon exploration and development.

From about 2015, Energia and now Altamin Limited (Altamin) (ASX:AZI) have been conducting exploration and development activities, and in November 2021 completed a Scoping Study on the project. From this study, Altamin reported a total production target of 6.0 million tonnes from an Indicated and Inferred Resource of 7.79 million tonnes grading at 6.8% zinc and 1.8% lead, containing 77% Indicated and 23% Inferred Mineral Resources at or above a cut-off grade of 3.5% zinc equivalent at an annual mining rate of 800,000 tonnes over the proposed nine-year life of mine.⁴

On 25 July 2022, Altamin announced that Appian, a global specialist mining private equity fund with expertise in financing and development of mining projects, planned to invest up to US\$65 million to earn up to a 67.4% interest in Gorno.⁵ The project is currently undertaking a Feasibility Study.

Should this be successful, will we see the first hard-rock mine being developed in Italy in 40 years?

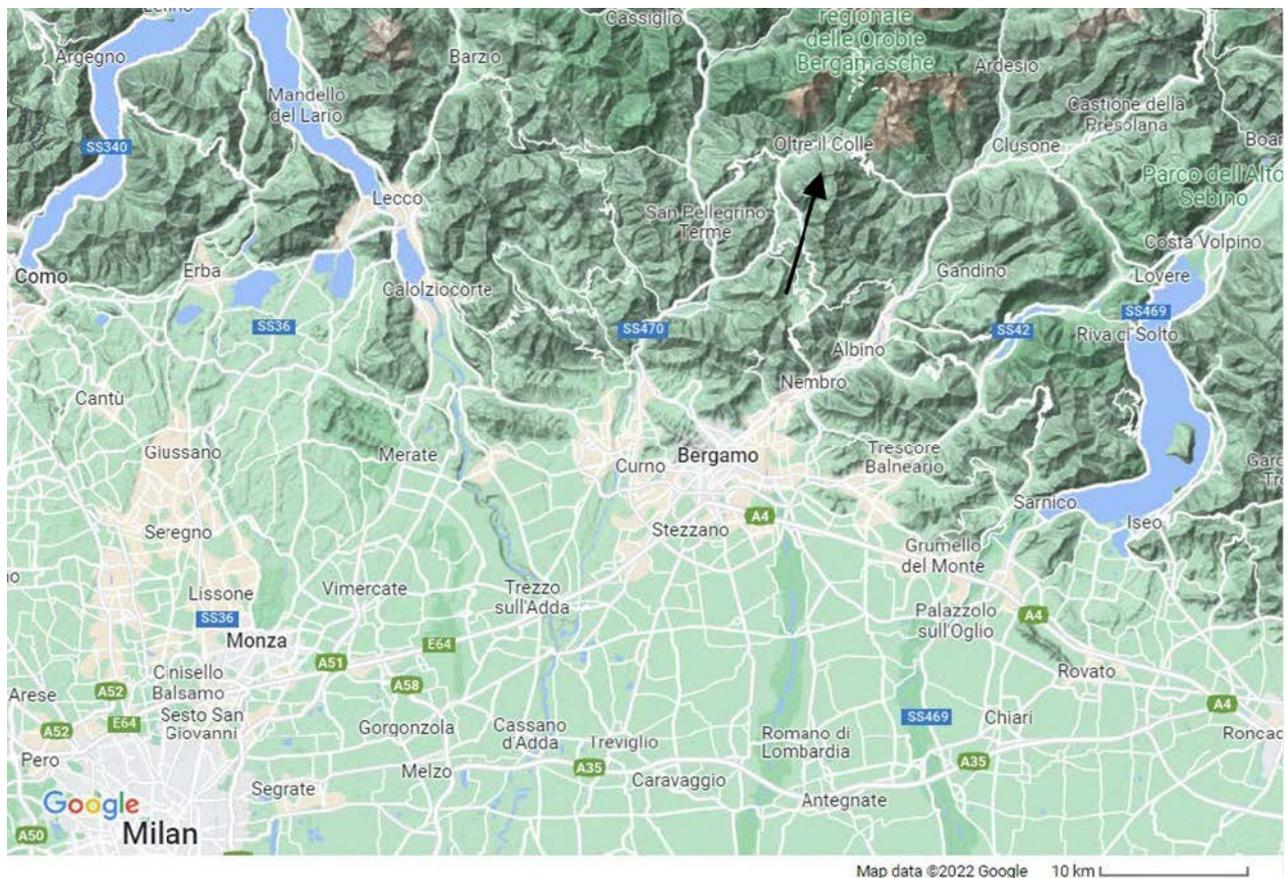


The Gorno Zinc Mining District

Deposits of zinc can be found spread from the eastern branch of Lake Como eastwards to Gorno in the Val Seriana. The Gorno district itself is a dense concentration of Triassic Mississippi-Valley-Type zinc-bearing mineralisation between the Val Brembana and Val Seriana, respectively, from the villages of Dossena in the west and Gorno in the east. The Gorno district, encompassing the deposits of Dossena and Gorno, is the single major zinc ore source in the Bergamo region, and for that matter in continental Italy, and in the early 20th Century it was named among some of the largest zinc mining regions in the world, supplying both calamine and sulphide ore (Moulden, 1916).⁶

The Gorno Project is centred on the town of Oltre il Colle in semi-mountainous terrain with elevations ranging from 600 m to 2,500 m above sea level, with changes in elevation characterised by very steep slopes and incised river valleys (Figure 2.1). The area immediately above the Gorno deposit is dominated by the steep catchment area of the Val Vedra and Val Parina valleys.

Figure 2.1 The location of Oltre il Colle (arrowed) in the Bergamesque region of northern Italy



The climate at Gorno is typical of the southern alpine region, with short, mild summers and long winters. The temperatures in summer have a mean of 17.3°C and average monthly rainfall of 101 mm. The temperatures in winter have a mean of 2°C with an average monthly snowfall equivalent to 115 mm of rainfall. The peak periods of precipitation occur in April–May and October–December.

Oltre il Colle itself is a picturesque village and is linked closely to the village of Zorzzone to the north (under which is a part of the orebody) and Zambala Basso and Zambala Alto to the east (Figure 2.2). Only about a third of the houses are occupied outside of holiday months and weekends, and the area is popular with hikers and skiers from urban areas. The area has seen significant post-World War II depopulation, and the permanent population of Oltre il Colle has halved since the 1950s (Wikipedia).⁷

Figure 2.2 Taken from Oltre il Colle looking eastwards towards Zambala Alto

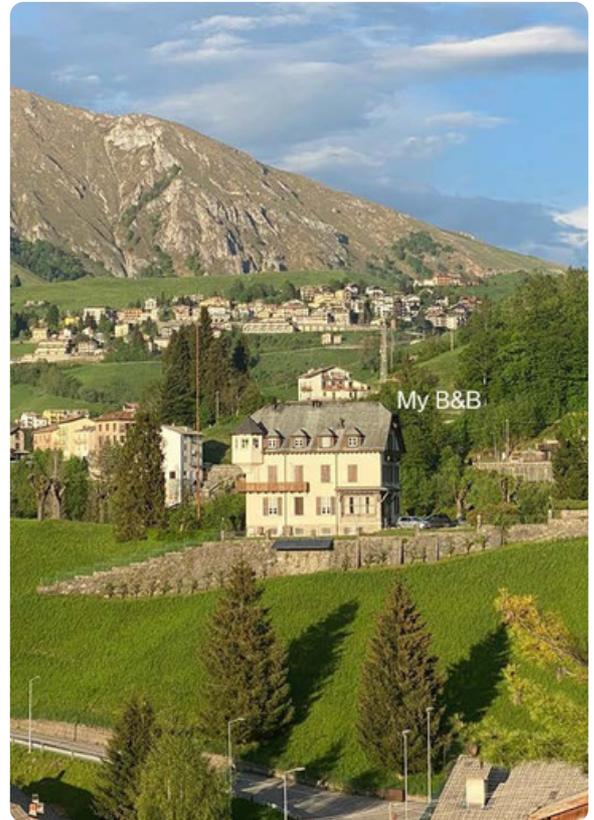
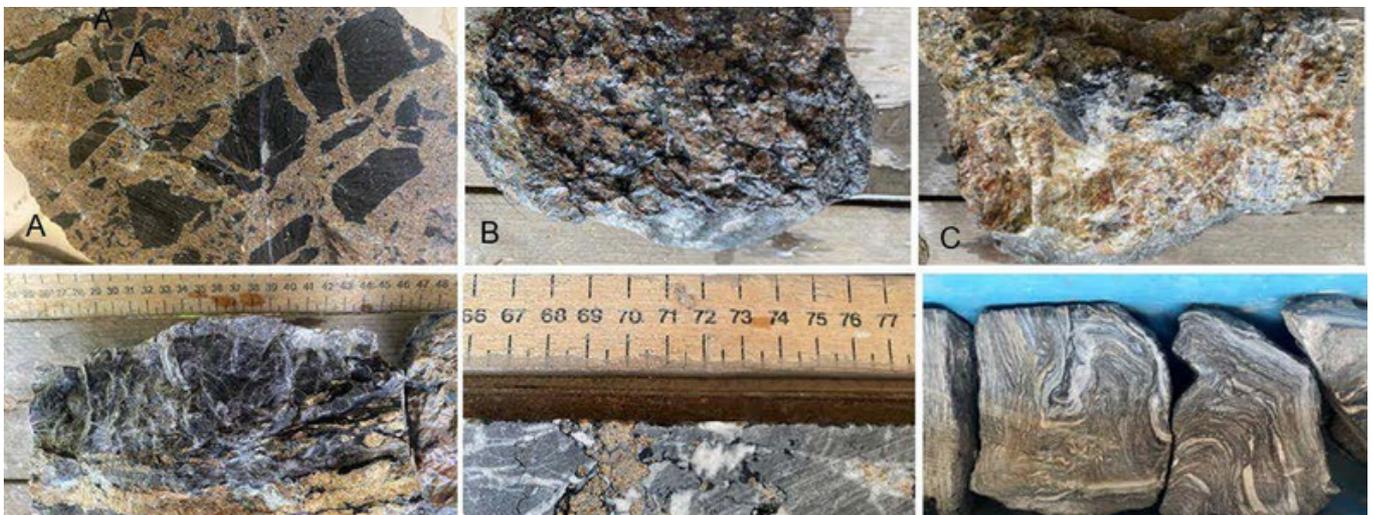


Figure 2.3 shows some mineralisation types at Gorno. Part A shows sphalerite and galena in brecciated limestone; B shows mineralisation in black shales; C and D show mineralisation in Breno limestone; and E and F show mineralisation in shear zones.

Figure 2.3 Mineralisation types at Gorno



Geoheritage Museum

Historical underground workings, and some surface pits, extend along a strike of some 8 km from Oltre il Colle to Riso, to the southeast. From Oltre il Colle, a winding road (called the SP46) with magnificent views takes you over the Zambla Pass and into the Riso Parina valley, which stretches to the main road (the SS671) connecting to Bergamo (Figure 3.1).

Figure 3.1 The area of historical underground workings and new exploration and development activities (the museum visited is at Riso)



The Gorno ecomuseum is situated in Grassobbio but was closed at the time of the visit. A secondary museum is situated at the opening of the Riso Parina tunnel, which connects underground workings over a distance of 8 km to Zorzene, adjacent to Oltre il Colle. This Altamin-supported museum has a large selection of rock specimens, historical maps, and underground artefacts and one can arrange access underground. Underground access was by small train (Figure 3.2) to the Selvatici underground mining section. On the way we passed a small 560 kW turbine that was installed in 2007 and provides power for the region. The exposures of sphalerite and galena mineralisation in the host dolomites were magnificent, and reasonably fresh, considering that some of the excavations dated back 40 years or more.

The mining museum contains rock specimens from the region, including from the Gorno mines area, and mining artefacts such as a good selection of carbide lamps. There is even a section on fossils from the region. There are some magnificent specimens, although the labelling could be a bit clearer.

Figure 3.2 shows: A – the small engine used to transport visitors into the mine; B – an old mining map of the area; C – underground mineralisation; and D – the museum custodian Severo Guerinoni with Matt Mullins, Altamin geologist Niccolò Fiori, and Altamin project manager Marco Milani.

Figure 3.2 Scenes from the Riso Parina Mining Museum



Figure 3.2 The museum custodian Severo Guerinoni in the main section of the museum



Conclusions

Are we about to see a revival of zinc mining in the Bergamesque Alps? The grades and tonnages are impressive, with significant upside tonnage potential. Although the proposed mining footprint will be almost exclusively underground and will provide some well-needed jobs in the area, there is understandably some nervousness on the environmental and social impact side.

The exploration and development activity is likely to see a revival in interest in the history of mining in the area, and further research into the archaeometallurgical sources of the zinc for Roman bronzes. As indicated by Pliny, Tizzoni¹ and Merkel², there is a rich history of zinc mining that will be explored further.

In the meantime, if you happen to be in the area, the museum at Riso Parina is well worth a visit.

References

- 1)Tizzoni M., 1996. Condensatori per la produzione dell'ossido di zinco da Conca del Naviglio aMilano. *Notizie Archeologiche Bergomensi* 4, 111-120. (Translated using DeepL Pro).
- 2)Merkel, S.W. (2021). Calamine of the Bergamasque Alps as a possible source of zinc for Romanbrass: Theoretical considerations and preliminary results. *Periodico di Mineralogia* (2021) 90, 247-259
- 3)Grant M., 1946: *From Imperium to Auctoritas, A Historical Study of Aes Coinage in the RomanEmpire 49 B.C.-A.D. 14*. Cambridge University Press, Cambridge.
- 4)Altamin ASX announcement, 15 Nov 2021: Updated Mineral Resource for Gorno
- 5)Altamin ASX Announcement 25 July 2022: Altamin Secures A\$94M Appian Funding Deal for Gorno
- 6)Moulden J.C., 1916. Zinc, its production and industrial applications. *Journal of the Royal Society of Arts*, 64, No.3314 (May 26, 1916), 495-513.
- 7)https://en.wikipedia.org/wiki/Oltre_il_Colle

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